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An anthropological examination of classic Maya burials from Moho Cay, Belize: skeletal and dental evidence of demography, diet and health

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AN ANTHROPOLOGICAL EXAMINATION OF CLASSIC MAYA BURIALS FROM MOHO CAY, BELIZE: SKELETAL AND DENTAL EVIDENCE OF DEMOGRAPHY, DIET, AND HEALTH

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ABSTRACT

In the Maya area, archaeological excavations have yielded an abundance of skeletal material from a multitude of sites throughout Belize, Guatemala, Mexico, El Salvador and Honduras. In 1979, a series of excavations led by Heather McKillop at Moho Cay, Belize, revealed a number of human interments. This thesis analyzes the Moho Cay skeletal collection composed of remains from eight discrete Late Classic (A.D. 600-800) burials and nine other archaeological units.

Skeletal and dental analysis of the remains included assessing minimum number of individuals per burial and establishing age and sex for each individual. The bones were also examined for signs of skeletal and dental pathology, as well as cultural modifications. Additionally, this thesis includes chi-square analysis of the occurrence of dental pathology and level of attrition as related to tooth class.

As pathologies of the skeleton are direct reflections of the individual's diet and health, the findings of this analysis present a picture of the health and diet of the Moho Cay community. Overall, this study has found that the Moho Cay Maya had moderate dental health and good overall health since few cases of skeletal pathology were observed. The results of this research do not corroborate the hypotheses of Late Classic decline in public health.

INTRODUCTION

The study of human skeletal remains can provide insight into the population composition, health, lifestyle, and status among other traits of prehistoric cultures. Combined with other archaeological data, osteological analysis reveals what it was like to be a member of a past culture and society specific to that time and place. "A human burial contains more anthropological information per cubic meter of deposit than any other type of archaeological feature" (Peebles 1977:124). Osteological examination of burials must detail the number, age, and sex of individuals, as well as observations of trauma, taphonomy, pathology, and cultural modification.

In the Maya area, archaeological excavations have yielded an abundance of skeletal material from many sites throughout Belize, Guatemala, Mexico, El Salvador, and Honduras. These sites range from small island settlements to large, inland metropolis centers.

In 1979, human remains were excavated at Moho Cay, Belize, under the direction of Heather McKillop. Moho Cay was a permanent trading port that facilitated shipment of exotic goods and marine resources from along the Caribbean, as well as between the coast and inland Maya cities via the Belize River (Healy et al. 1984; McKillop 1980, 1984, 2003). Eight discrete burials and nine other archaeological units containing human bone were discovered during the field season. The burials were dated to the early part of the Late Classic time period of Maya civilization (A.D. 600 to 800) based on associated ceramics (McKillop 1980, 1984, 2003).

The Moho Cay skeletal material was brought to Louisiana State University in the summer of 2002. The current study is a descriptive analysis of these remains.

Preliminary osteological assessment of the demographic profile (including number, age, and sex), skeletal and dental pathology, and cultural modifications of these remains are presented. Additionally, statistical analysis using two-way tables and chi-square was conducted to test for associations between the occurrence of dental pathology and level of attrition as related to tooth class. The main research questions addressed in this study are: what can the human skeleton remains reveal about life during Classic Maya society at Moho Cay and how does this relate to the phenomenon of the Classic Maya collapse?

LITERATURE REVIEW

This thesis research focuses on the osteological examination of a small collection of Late Classic Maya burials. A plethora of studies have been conducted on Maya skeletal and dental remains in relation to the health and diet of each population and Maya civilization at large. These studies have resulted in a large body of literature, which evidence the complexity of Maya civilization. Of particular interest to researchers is the apparent collapse of the Maya culture at the end of the Late Classic period. Speculations of both sociopolitical and ecological factors have been attributed as possible causes of this collapse (Glassman and Garber 1999). Some researchers suggest that there was a general decline in public health associated with the Maya collapse as evidenced by increased incidence of disease and nutritional stress markers in bone and teeth.

Pathologies that leave markers on bone are generally associated with the degeneration of joints or the disruption of normal growth processes specifically during times of nutritional or metabolic stress. These diseases provide insight into the environment and resources of an individual's childhood and/or adulthood near the time of death. Degenerative conditions, such as osteoarthritis and degenerative joint disease (DJD), provide a picture of stress placed upon the joints during chronic lifestyle and subsistence activities, as well as demonstrating typical age-related changes of the individual's joints. The different causes of nutritional or disease related defects of the bone are vast. However, these insults do represent stress events substantial enough in length and severity to interfere with normal development of the skeleton.

Osteoarthritis and DJD are conditions in which bones display varying degrees of osteophyte development, lipping, porosity, and eburnation of the joint surfaces. The causes of these pathologies are related to age and lifestyle activity, respectively.

Discussions of these pathologies in Maya skeletal populations are limited. Saul and Saul (1991) found minimal incidence of osteoarthritis in the Preclassic Cuello population. Among this group, the vertebral column and the phalanges of the foot and hand were affected. Due to the poor preservation of articular surfaces, presence of osteoarthritis was noted in few individuals, and the researchers could not provide any conclusions. Similarly, Chase and Chase (1996) observed osteoarthritis in the vertebrae of two males of the lower tomb of Structure A34 at Caracol. Again, the pathology was only mentioned descriptively.

Evidence of DJD was detected frequently in the remains of Ambergris Cay (Glassman 1995). DJD was present in the shoulder, elbow, wrist, hip, knee, and ankle in this group (Glassman and Garber 1999). The most common site for evidence of DJD was the proximal ulna. DJD of this joint was seen exclusively in four males. Analysis of DJD at Ambergris Cay may reflect sexual differentiation of subsistence activities (Glassman and Garber 1999:128). In a marine environment, stress of the elbow is high during the hyperextension of the arms involved in canoeing activities. Sexual differences in DJD on Ambergris Cay are in line with findings of other farming groups. In agricultural populations, researchers have found sexual differences in the occurrence of osteoarthritis. Larsen (1982) stated that males of a prehistoric island population off the Georgia coast show a higher prevalence of osteoarthritis at the elbow, knee, and vertebrae than do females.

Periostitis is the inflammation of the periosteum or outer layer of bone caused by trauma or infection (White 2000). As with osteoarthritis and DJD, periostitis is usually mentioned with respect to presence and frequency, but seldom discussed since there are multifarious causes of the condition. At Cuello and Altar de Sacrificios, few individuals displayed periosteal lesions. Saul (1972) speculated that individuals at Altar were more susceptible to periosteal infections of hemorrhages enhanced by structural weakness of soft tissues attributed to vitamin C deficiencies. Saul and Saul (1991) did not offer any explanations for the presence or absence of periosteal lesions at Cuello. Thirteen individuals (31%) of Ambergris Cay displayed periosteal lesions (Glassman 1995). In later analysis, Glassman and Garber (1999) suggested that infectious disease was the health risk factor responsible for the high presence of the pathology in the Ambergris Maya.

Porotic hyperostosis and cribra orbitalia result from iron deficiency anemia and cause stippling or pitting on the frontal, parietal, and occipital bones of the skull. Individuals with diets low in protein and high in carbohydrates, such as members of maize-dependent populations, will exhibit evidence of this nutritional disease. Whittington and Reed (1997) reported high rates of porotic hyperostosis in their study of skeletons from low status individuals at Copan ranging from the Middle Classic to Postclassic periods. Similarly, Storey (1999) examined individuals according to status from the Late Classic period at Copan. Those individuals of low status had the majority of lesions, while those classified as high status were least affected by anemia. These studies might indicate that food resources were distributed according to status, and those individuals of high status were afforded better health due to differential access to food. Storey (1999:175) suggests the difference "indicates differential susceptibility to anemia during childhood."

In the Preclassic site of Cuello, Saul and Saul (1991) reported a virtual absence of porotic hyperostosis. The Late/Terminal Classic Maya of Ambergris Cay exhibited equally low incidence of porotic hyperostosis (Glassman 1995). Coincidentally, the two affected Ambergris individuals were classified as low in status rank by the researchers.

Harris lines are radiographic lines of evidence of dietary or disease stress in which growth of the long bones is arrested. Glassman and Garber (1999) examined a subsample (n=6) of the Ambergris Cay collection. While three of the six individuals displayed at least one Harris line, the researchers caution that those adults without the pathology may have obliterated any traces of Harris line in subsequent bone remodeling. Therefore, Glassman and Garber suggest that Harris lines were not uncommon in the population and reflect episodic periods of disease. No other studies of Maya were found in which detailed discussion of Harris lines was given. While discussions and explanations of skeletal pathology are limited due to the diverse causes, these insults do represent stress events substantial enough in length and severity to interfere with normal development of the skeleton.

Stature as a reflection of health and diet of the Maya has been the focus of numerous studies. Adult stature is a cumulative indicator of childhood growth, in part based on genetic predisposition and nutrition. A decrease in stature of the Maya has been used to show a nutritional decline, in that individuals were not able to reach full growth potential in times of dietary stress associated with the Late Classic collapse (Haviland 1967; Saul 1972; Willey et al. 1965). Stewart (1953) was the first to suggest the existence of stature reduction over time in the Preclassic Maya skeletons of Zaculeu, Guatemala.

At Barton Ramie, a decrease in robusticity seen in long bone diameters was used to infer that a decrease in stature would also be expected (Willey et al. 1965). Poor preservation at this site inhibited reliable stature reconstruction. Haviland (1967) found a statistically significant decrease in male height between the Early Classic and Late Classic periods at Tikal. The difference in stature over this time was nearly ten cm in males, while females showed little change in stature over time. Saul (1972) presented findings of widespread disease and infection at Altar de Sacrificios and concluded that a decline in stature over time had occurred at the site.

Danforth (1999) compiled a comprehensive comparison of stature of 125 lowland sites ranging from Preclassic to Modern times. This study revealed a small decrease in both male and female stature from the Preclassic to the Late Classic. Male stature then rebounded to previous heights in the Postclassic, while female stature remained relatively stable from the Late Classic on. Marquez and del Angel (1997) also compiled a comprehensive database from sites throughout the Yucatan. Again, the decline in male stature was greatest from the Preclassic to the Classic. Female stature from this comparative study did not show as much variation as male stature. However, "analysis of the mean lengths of the various bones by culture period indicates…that there was a reduction of every bone between the Preclassic and Classic" (Marquez and del Angel 1997:57). Danforth's findings (1994, 1997) in another comparative study showed that Late Classic males of Barton Ramie were taller than their counterparts from the larger site of Tikal. These results provide evidence of better health conditions at smaller sites and further strengthen the association between larger population size and decrease in public health.

Glassman (1995) related male stature variations among the Ambergris Maya to status. Those males assigned to the elite rank were two of the three tallest individuals of the sample, while the shortest individual was of a low cultural status. Haviland (1967) noted that decrease in male stature from the Early Classic to Late Classic was most pronounced in nontomb burials of low status individuals. These correlations of stature and status suggest that individuals of high status were better able to meet their genetic growth potential due to better access to nutritional resources. In contrast to these studies, Storey (1999) found little significant variation in stature according to status group at Copan. While individuals of the low status group were generally shorter, all three status groups were of similar stature.

The varied findings of stature have generated hypotheses of decline in public health over time as related to small and large sites, males and females, and levels of social differentiation. Most of the support for stature reduction of the Maya from the Preclassic to the Postclassic is based on small samples from a limited number of sites (n=3) and individuals. Danforth (1994), however, reported that stature studies have been plagued by methodological inconsistencies. Indiscriminant use of stature formulae from various long bones causes a high degree of variability in stature estimations and hinders any reliable comparisons. Furthermore, there is no consensus as to the precipitating reason for a populational decline in stature. Stinson (1992) argued that a decline in stature is an adaptive response in that smaller bodies require less food to sustain; thus, stature reduction would not be an accurate indicator of nutritional stress. Lastly, subjective methodology of status definition and assignment has further complicated the already complex social stratification of Maya society in relation to stature, health, and diet.

Health statuses of various settlements have been directly correlated to diet through dental studies of the Maya. Carious lesions are obvious areas of enamel breakdown that occur as holes or pits in the crown. Magennis (1999) reported a dramatic increase in caries frequency during the Late/Terminal Classic period at Kichpanha.

Whittington (1999) found high frequencies of caries in a population at Copan. Preclassic Cuello inhabitants commonly displayed caries, as well as calculus and marked attrition (Saul and Saul 1991). Dietary carbohydrate intake has been directly correlated with these dental defects. Therefore, diets high in carbohydrates, such as maize, yield a higher occurrence of carious lesions. These data support the decline in public health through the heightened occurrence of caries and suggest a dietary increase of carbohydrates during the Late Classic.

On the other hand, White (1998) found a decrease in caries rate at Lamanai from the Preclassic to Late Classic periods. This decline in caries was linked to a decrease in maize production and consumption. Also, residents of Lamanai supplemented their diet with nearby marine resources. Although Whittington (1999) reported high caries rates at Copan, he did find a similar decrease in caries frequencies at the time of collapse. He also discovered higher occurrence of caries in females and suggested a higher dietary intake of carbohydrates for females.

Glassman and Garber (1999) observed low, constant rates of caries in a population at Ambergris Cay. They suggest that access to marine resources at this site allowed more protein in the diet and less reliance on carbohydrates, thus yielding an overall lower caries rate.

Enamel hypoplasias can provide further insight into individual health status. Lines of enamel hypoplasia are gross evidence of periods of metabolic and nutritional disturbances that occur during childhood. "Although hypoplasia can also be caused by infectious disease, in North America there is a strong nutritional association between its incidence and increasing dependence on maize agriculture" (White 1997:175). In Danforth's investigation (1997) of incidence of hypoplasias at three Late Classic sites of

Barton Ramie, Seibal, and Tikal, the highest frequencies of hypoplasias occurred at the largest site, Tikal. This study suggests that childhood stressors that cause the cessation of enamel formation were greater where high population size lowered public health. Dental data, specifically high frequencies of enamel hypoplasia, from Altar de Sacrificios (Saul 1972) support hypotheses of cultural decline at that site. Populations from Lamanai and Pacbitun show consistent rates of hypoplasia over time, inferring that physiological stresses on infants remained uniform across all time periods (White 1997). Similarly, Storey (1999) examined status and health at Copan and found that hypoplasias occurred in all status groups, with no statistically significant differences further reiterating the commonality of hypoplasias and nutritional stress events. Saul and Saul (1997) found higher incidences of hypoplasias in females than males, 63 and 49 percent, respectively. This evidence suggests that female infants suffered from more nutritional stresses than did male infants.

Accretions of dental plaque, known as calculus, and the occurrence of abscesses are not frequently studied in archaeological contexts. These maladies are usually noted in combination with the aforementioned dental pathologies as indicators of poor oral health caused by diets high in carbohydrates. The factors contributing to calculus formation and accumulation are complex. Hillson (1979) showed an inverse relationship between the presence of calculus and caries. He suggests that calculus acts as a protectant against caries in that the tooth surface covered by calculus is not susceptible to caries formation. However, high amounts of calculus can lead to other dental problems. Therefore, no substantial research has been performed to link the presence and severity of calculus independently with other dietary and health phenomenon of Maya populations.

Likewise, abscesses are glossed over as part of a suite of poor dental health, but little other information is offered.

Chemical analyses, specifically isotope studies, have been conducted to infer diet in skeletal populations. Variations of carbon and nitrogen isotope ratios of bone collagen can be used to gain insight into individual dietary consumption (White et al. 1993). Isotopic analyses of carbon address the importance of maize in the Maya diet, while nitrogen isotopic analyses focus on the dietary protein source. Coyston and colleagues (1999) conducted isotope analyses on populations from Lamanai and Pacbitun. Maize made up the large part of individual diets at both of these sites. However, residents of Lamanai did not have as heavy a reliance on maize, for they exploited marine and aquatic food resources in addition to agricultural products.

Food was also used to delineate social status at these sites. White's (1997) study of high-status diet at Lamanai and Pacbitun revealed that the elite of Lamanai consumed less maize than did their Pacbitun counterparts (White et al. 1993; White and Schwarcz 1989). Local foods were designated as high-status foods due to their function in ceremonial rituals. Those elite individuals who participated in rituals thus consumed more of these valued foods, such as deer, peccary, dog, and turkey (Coyston et al. 1999:240). Whittington and Reed (1997) concluded that commoners of low status at Copan had a diet high in maize and low in deer meat. These findings suggest that higher-status individuals experienced better health due to better access to more diverse nutritional resources.

Reed (1999) found that maize was the staple in the diet of inhabitants of the Copan Valley. In addition, Reed discovered age and sex related differences in maize consumption. Female consumption of maize decreased with age, while male maize consumption remained consistent for all age categories (Reed 1999:192). Whittington and Reed (1997:168) noted similar sex-related differences, for "males had more restricted diets and ate a higher proportion of maize than did females." Isotopic analyses on individuals from Altun Ha, Belize, performed by White and colleagues (2001) revealed a protein-rich diet of marine and reef resources. While the Altun Ha diet contained significant quantities of fish and seafood, maize remained the staple carbohydrate. White et al. (2001:381) also revealed gender-based differences, in that males consumed more maize and meat than did females. These isotopic analyses have been used to gain insight into specific dietary consumption and to corroborate dietary differences of status and gender as evidenced in pathological markers.

Plant food remains recovered from several ancient Maya sites indicate that the coastal Maya focused more on tree-cropping than planting corn fields, especially on small island sites such as Wild Cane Cay, Tiger Mound, Frenchman's Cay, and Pelican Cay in the Port Honduras of southern Belize (McKillop 1994, 1996). Similarly, the meat consumed by coastal Maya included more seafood, notably manatee at Moho Cay (McKillop 1984), than the inland Maya diet.

All of these studies have contributed to a complex picture of diet and health in Maya populations from the Preclassic to Postclassic periods. The literature of Maya skeletal and dental studies reveals intersite and intrasite variation of pathologies with respect to frequency, gender, social differentiation, and temporality. The basis of a proper osteological analysis is a representative sample of skeletons reflecting the ages and sexes that would have been present at the time of site occupation. Small sample sizes have prevented researchers from reaching any regional hypotheses of dietary or health patterns with statistical significance. Unfortunately, the tropical soils of the Maya region are not conducive to bone preservation. Poor preservation detrimentally affects the recovery of more gracile female skeletons, as well as juvenile skeletal material. The underrepresentation of females and juveniles in these studies has limited significant comparisons over time within and between age groups and the sexes.

Regardless of these problems, the information to be gained from archaeological analyses of this culture complex is limitless. Site-specific dietary and health studies can be compiled to provide a picture of regional diversity and variation. An aggregation of comparative studies from a number of Maya sites is needed in order to reflect more accurately health and diet, so that definitive models of collapse can be generated.

<u>Site Background</u>

Moho Cay is situated at the mouth of the Belize River. This island was occupied from the Late Preclassic through Postclassic times (McKillop 1980, 1984, 2003). The rise of sea level inundated the site, which prevented full appreciation of the significance of Moho Cay in the Maya trade economy until excavations in 1979 uncovered a wealth of artifacts in context. The strategic location of Moho Cay placed the island between major riverine and coastal transportation routes. As such, Moho Cay assisted in the trade of both local marine resources and exotic ritual goods to inland Maya sites in the upper Belize River valley (Healy et al. 1984; McKillop 1980, 1984, 1985, 2003). Ritual goods desired by the Maya at inland cities, such as stingray spines, obsidian, and jade, as well as marine resources of manatee, fish, and mollusks, likely originated from or passed through Moho Cay in the transportation and trade process.

The skeletal material from Moho Cay was recovered from eight discrete burials and nine other archaeological units during the first and only field season in 1979. Unfortunately, dredging of a harbor destroyed the site just prior to the second archaeological field season in 1980 (McKillop 1984). The interments were placed either under house floors prior to construction or were dug into preexisting floors (McKillop 1980, 2003). Post molds were encountered in the immediate vicinity of Burials 1, 3, and 4 (McKillop 1980), while bones from the Feature 9 Burial and Units 11 and 11a were situated under a layer of red soil indicating a house floor (McKillop 2003).

After excavation, the remains were stored at Trent University in Peterborough, Ontario, until this researcher retrieved and transported them to Louisiana State University (LSU) in the summer of 2002. At LSU, the bones were cleaned, identified, reconstructed, and catalogued in order to conduct a complete osteological examination.

This study followed the data collection techniques and guidelines described in *Standards for Data Collection from Human Skeletal Remains, Research Series No. 44* by Buikstra and Ubelaker (1994) and *Human Osteology: A Laboratory and Field Manual, Fourth Edition* by Bass (1995). The information recorded included skeletal inventories, as well as assessments of age, sex, dentition, pathologies, trauma, and taphonomy. In order to provide an osteological profile of the population, these data were collected as a basis for future research.

BURIAL DESCRIPTIONS

Preservation of the skeletal remains was variable. Individuals were represented by mostly complete articulated skeletons, as well as partially articulated and incomplete nonarticulated skeletal material. Due to their recovery from soil that was variously wet or dry following the rainy season-dry season weather, destruction of some of the more fragile bones and long bone epiphyses was common.

Minimum number of individuals (MNI), age, and sex were ascertained as possible for each burial. Specific age estimations were given only for the juveniles according to the dental development and tooth eruption sequence in Bass (1995) and size comparisons with other juvenile material. Adult status was determined by the exhibition of complete fusion of long bone epiphyses, eruption of third molars, and/or closure of cranial sutures, in addition to observations of overall physical size. Estimations of sex did not include the juveniles since sexual dimorphism of the skeleton does not occur until puberty.

<u>Burial 1</u>

Burial 1 includes remains from an adult and two juveniles. The remains of the adult individual, though fragmentary, were mostly complete. Due to the location in wet soil, the adult cranium was highly warped. Elements not recovered were the right patella, left femur, and right fibula. The hands and feet were not complete, but bones were collected from each class of bones in the hands and feet, such as the carpals, metacarpals, tarsals, metatarsals, and phalanges. Since side did not duplicate in any element present, the adult remains represent one individual.

The juvenile remains were restricted to teeth, and cranial and mandibular fragments. The cranial fragments assessed as juvenile were very thin with jagged, fingerlike sutures that showed no signs of fusion. This morphology contrasted strongly with the thick cranial fragments of the adult.

There were two juvenile mandibular fragments in Burial 1 (see Figure 1).

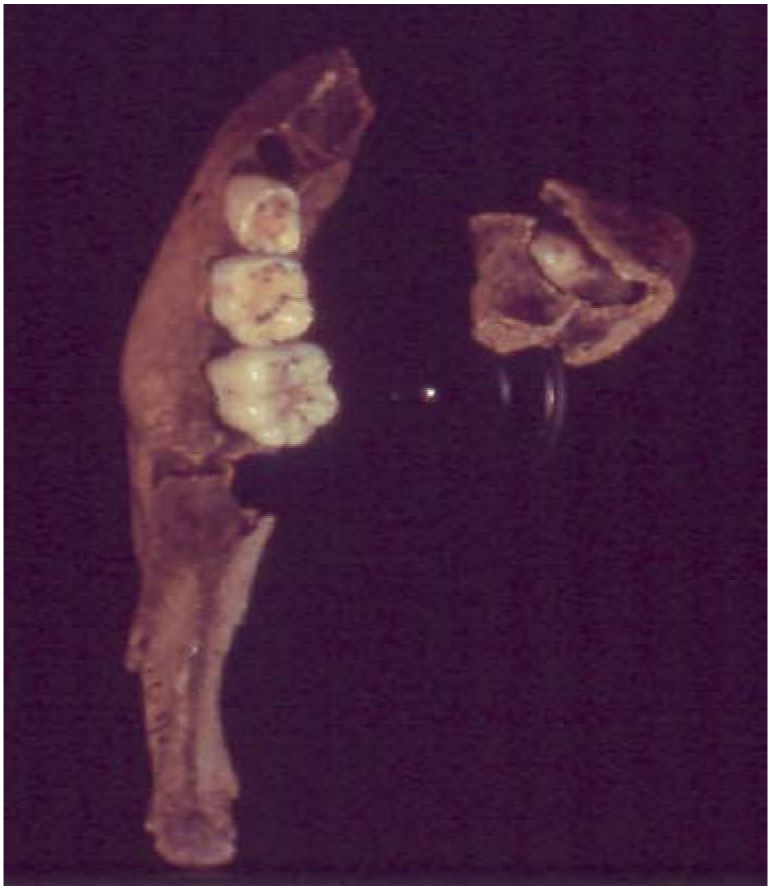

Figure 1: Mandibular Fragments of Juvenile 1 of Burial 1

The larger mandibular fragment contained the left deciduous molars and the left permanent first molar. A crypt was present for the left permanent second molar, but was broken with the tooth absent. The second mandibular fragment contained the right permanent canine still developing in the bone with approximately half of the root developed. Deciduous teeth not in the bone included several molars, two maxillary incisors, and two canines with complete roots. The incisors showed a high degree of attrition on the incisal surfaces, while the molars and canines exhibited several carious lesions. Crowns of developing permanent teeth with little to no root formation were discovered, including several premolars and molars. Other juvenile teeth included the permanent maxillary incisors, one maxillary canine, and two mandibular incisors with partially formed roots.

Due to the duplication of both deciduous and permanent maxillary incisors with roots, an estimation of two juveniles was given to this burial. The deciduous incisors with high attrition and complete roots cannot belong to the same individual as the developing permanent maxillary incisors with partial roots because the erupting permanent incisors would have resorbed some portion of the deciduous roots (Bass 1995). Therefore, the MNI of Burial 1 is three, with one adult and two juveniles.

The adult individual of Burial 1 was a male. Sex estimation was based on observations of the cranium, mandible, and ilium. Cranial fragments observed included an occipital fragment, frontal fragment, and both temporal bones. The occipital fragment had a pronounced, rugous nuchal muscle attachment site. The frontal fragment had a large brow ridge over the right eye orbit and a prominent glabella. The left temporal bone had a bulbous mastoid process with a high degree of inferior projection. The zygomatic root of the left temporal bone extends over the external auditory meatus (EAM). The right temporal bone was more fragmentary, but the zygomatic root was still visible and extended over the EAM. The right mastoid process was fractured, but the anterior half still exhibited a high degree of inferior projection. The mandible fragments were thick in diameter and contained molars with large overall crown size. Other features of the mandible typically used in sex determination were damaged or not present.

The right ilium, though only a small fragment, was examined for sexually diagnostic characteristics. The greater sciatic notch had a narrow angle. The presence or absence of a preauricular sulcus could not be assessed due to damage to the inferior half of the auricular surface. This suite of morphologies indicates that this adult was male.

Age estimations of the juveniles were based exclusively on the dental eruption sequences. The two mandibular fragments mentioned previously place Juvenile 1 in the age range of six to ten years old (see Figure 1). This estimation was established by the presence of the fully erupted left permanent molar, which occurs at age six, and the developing right permanent canine still in the bone. Generally, the permanent canine will be partially erupted through the bone by ten years of age (Bass 1995). The root apices of the molar are not fully formed, while half of the canine root is formed. Juvenile 1 also retained both left deciduous molars in the mandible, which would both be lost around the age of ten (Bass 1995). Juvenile 2 was estimated to be three to five years old because the deciduous anterior teeth have complete roots (i.e. no resorption has occurred) and show incisal attrition, as well as several carious lesions (see Figure 2). Therefore, Juvenile 2 used these anterior teeth long enough to develop dental wear and pathologies, but died prior to the occurrence of any root resorption by the developing permanent teeth.

For the adult of Burial 1, the age-related morphologies were the presence of calculus on the molars and osteoarthritis of the lumbar vertebrae. Two contiguous lumbar vertebrae had moderate osteoarthritic lipping of the superior and inferior margins of the body.

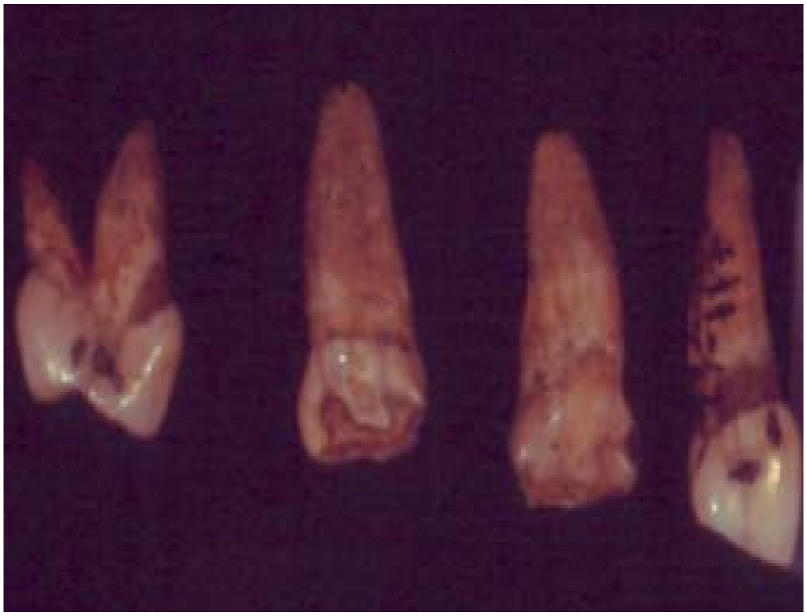

Figure 2: Deciduous Teeth of Juvenile 2 of Burial 1
Showing High Attrition and Carious Lesions

Burial 2a

Burial 2a contains most of the remains of one individual. This burial was mostly complete with missing elements being the right ulna, left radial shaft, left patella, and left fibula. Only two carpals, three metacarpal fragments, and four phalanges represented the hands. The only recovered aspect of the feet was the left cuboid. The vertebral column was well preserved with three cervical, nine thoracic, and all five lumbar vertebrae complete. The MNI of one adult was established as no duplication of postcranial elements occurred.

The relatively complete pelvis, cranium, and mandible facilitated sex estimation of this adult. Both hip bones had wide-angled greater sciatic notches, evident preauricular sulci, and acetabulae small in size (see Figure 3). The temporal bones had mastoid processes of intermediate size and zygomatic roots that ended anterior to the EAM. The temporal line of the left frontal bone was present, but not prominent, indicating more gracile muscle attachment. The left frontal bone also displayed a sharp supraorbital margin and a gracile brow ridge and glabella. Mandibular dimensions included a gonial angle greater than 90 degrees and rounded chin. The mental eminence could not be assessed due to postmortem damage at the midline. Also, the overall size of

Figure 3: Right Hip Bone of Burial 2a Female

the premolar and molar crowns is small. The combination of these features lead to the assessment of this individual as a female.

This individual was assigned as an adult due to complete fusion of long bone epiphyses and cranial sutures. The cranial sutures were tightly fused, and portions of the coronal suture were obliterated.

<u>Burial 2b</u>

Burial 2b was comprised of fragments from the majority of the postcranial elements, excluding the hands. Most of the postcranial elements occurred in pairs of right and left or in pairs from the same side. For example, there are two left and two right calcanei, and two left patellae. However, fragments of three distinct left tibiae were identified. Thus, a final MNI of three individuals was established.

Sex estimation of the remains from Burial 2b is limited to dimorphism in size of matching elements since no bones with sexually diagnostic features were recovered. The two ulnae of this burial, though from different sides, are significantly different in size (see Figure 4). Both ulnae belong to adults and could not be from the same individual

Figure 4: Examples of Size Dimorphism
(Left to Right) Two Ulnae and Two Fibulae of Burial 2b

due to the size disparity. Other elements that exhibited this dimorphism in size were the tibiae and fibulae fragments. Therefore, the determination was made that this burial contained one male, one female, and one individual of undetermined sex. Age determination was not possible due to the fragmentary nature of the remains. The individuals were classified as adults based on the relative size of the long bone shafts.

Burial 3

The skeletal inventory from Burial 3 included fragments from the cranium, vertebrae, ribs, tibiae, and feet, as well as fragments of the left hip bone and one left ulna. One deciduous maxillary molar also was collected.

Due to the presence of two right tibiae, the MNI of two individuals was determined. Disparity in size occurred between the two right tibiae (see Figure 5). The

Figure 5: Two Tibiae of Burial 3 Showing Size Disparity (Top) Left Juvenile Tibia (Bottom) Right Adult Tibia

recovered left tibia matches the smaller of the two right tibiae in size. The tibiae matching in size are smaller than all other tibiae fragments of the collection assessed as adult. This size differential suggests that the smaller tibiae belong to a juvenile. The recovered deciduous molar corroborates the presence of a juvenile in the limited skeletal remains of Burial 3. Duplication of any other elements did not occur in this burial. Therefore, the MNI of Burial 3 is two, with one adult and one juvenile individual.

Sex estimation was hindered by the fragmentary nature of the remains. One right temporal bone exhibited a small, more gracile mastoid process. Likewise, the temporal line from a left frontal bone fragment is evident, but gracile in appearance. These two morphologies suggest that the adult individual was female. Age estimation of the juvenile was not approximated due to the insufficient material. Deciduous maxillary molars are generally retained up to twelve years of age, so the juvenile individual may have been less than twelve years old.

<u>Burial 4</u>

Burial 4 includes remains from three individuals. The adult remains represented two individuals, as there were fragments from two distinct crania (see Figure 6). With the exception of one left femur fragment, remains of the two adults strictly represented elements above the pelvic girdle. No ulnae, carpals, or phalanges were recovered. Juvenile remains included two cranial fragments with well-defined unfused sutures, as well as the left ilium, left ischium, and left femur with an unfused epiphyseal head (see Figure 7). Therefore, the MNI of Burial 4 is three, with two adults and one juvenile.

Estimations of sex of the two adults relied entirely upon cranial and mandibular features. The cranium of Individual 1 had a prominent nuchal crest, but the nuchal lines of muscle attachment were not prominent. Individual 1 also displayed a gracile temporal line and small brow ridge. The right temporal bone was ambiguous in sexually dimorphic characteristics. The mandible of Individual 1 had an everted gonial angle greater than 90 degrees and a rounded chin with a slight mental eminence. These features

Figure 6: Two Reconstructed Adult Crania of Burial 4

placed Individual 1 in the female range when seriated with other remains of the collection.

Individual 2 had large, bulbous mastoid processes with a high degree of inferior projection. The left zygomatic root extends as a crest over the EAM, while the right zygomatic root is not as defined. Damage to the occipital bone limited observations to the presence of a nuchal crest and inion hook. Prominence of the nuchal muscle attachments could not be assessed. Two different frontal fragments showed somewhat prominent left lateral and right medial brow ridges, and a prominent glabella. The mandible of Individual 2 featured a gonial angle that approximated 90 degrees and a square chin with a strong mental eminence at the midline. The left gonial angle flares laterally. The right gonial angle also exhibits lateral flaring, but is not as evident as the left angle due to damage. This suite of cranial and mandibular morphologies placed Individual 2 as a male.

Age estimation of the juvenile was based on the lack of fusion in the recovered elements (see Figure 7). The ilium and ischium were two distinct bones. Therefore,

Figure 7: Juvenile Remains of Burial 4
Left Ilium, Left Ischium, and Left Femur with Unfused Head

fusion in the acetabulum, which occurs around twelve years, had not begun. Fusion of the rami of the ischium and pubis was not evident even though the pubis was not recovered. These two elements fuse between the ages of seven and eight. Also, the epiphyses, the iliac crest, the anterior-inferior iliac spine, and the ischial tuberosity that appear at puberty, had not developed. The small epiphysis of the femoral head was unfused. The head unites between ages fourteen and nineteen. No other epiphyses of the femur were recovered.

Since all of these fusion events occur at various times throughout adolescence, size comparisons were made with an historic skeleton of a five to seven-year-old curated in the Louisiana State University Forensic Anthropology and Computer Enhancement Services (FACES) Laboratory. The two juvenile skeletons, though from vastly different time periods and cultures, were similar in size and exhibited similar stages of development. Therefore, the age of the juvenile of Burial 4 was estimated at five to eight years of age.

For the adults of Burial 4, the age-related features of cranial suture fusion, osteoarthritis of the vertebrae, and dental attrition affirmed assessment as adult. Individual 2 had tightly fused sutures, with the sagittal suture obliterated. Both adult individuals of Burial 4 displayed mild lipping of the cervical vertebrae. Individual 1 exhibited the most severe dental wear of all individuals in the collection, as well as the most lost or extracted mandibular teeth as demonstrated by remodeling alveolar bone.

<u>Burial 5</u>

The skeletal material from Burial 5 was restricted to the hands and elements below the pelvis with a few vertebral fragments. Presumably, the upper skeleton had eroded into the sea (McKillop 1980:37). This feature, designated as Burial 5, represents one individual, as no elements were duplicated.

Sex estimation of the Burial 5 individual relied entirely on observations of the reconstructed left hip bone (see Figure 8). Features of importance were the narrow angle of the greater sciatic notch, lack of a preauricular sulcus, large acetabulum, and a convex ischiopubic ramus. Based on these dimensions and features of the left hip bone, this individual was classified as a male.

For age estimation, the individual of Burial 5 was determined to be an adult due to comparable size of the postcranial elements of other adult burials of the collection. The only other indication of adult age was the presence of moderate osteoarthritic lipping of a lumbar vertebra.

Figure 8: Left Hip Bone of Burial 5 Male

Feature 9 Burial

Recovery of two mandibles in Feature 9 indicated that the burial contained at least one adult and one juvenile. The adult remains included fragments from most parts of the skeleton. Elements not present were the humerus, fibula, and pelvic girdle. Bones of the hand were limited to one left scaphoid and two proximal phalanges, while the only bone of the foot was one right talus. The only indication that these remains represent two individuals was the two femoral shaft fragments. Due to disparity in size of the femoral shafts, the two femoral fragments represented two adult individuals. The commingled, fragmentary nature of the remains hindered classification of the remains as separate individuals (i.e. Individuals 1 and 2), as the only element to duplicate was the femur.

Juvenile material was not as extensive as the adult remains. Juvenile remains were limited to a mandible, left scapula, left tibia, one cranial fragment, and a few loose teeth in addition to those teeth still in the mandible. The eruption sequence of the mandibular teeth placed the juvenile material in a specific age range. However, upon size comparison with an historic case of a five to seven year old in the FACES Lab, the tibia and scapula of the Feature 9 Burial were comparable in size, though slightly smaller (see Figure 9). This age range is significantly younger than the age range estimated from the dental eruption sequence. Thus, two juveniles were present in the Feature 9 Burial. Another indication of two juveniles is the presence of a deciduous incisor with a portion of the root preserved. The deciduous incisors would have been replaced in both the maxilla and mandible by the stage of the dental eruption sequence the mandible exhibits. Secondly, no root of the deciduous incisor would be preserved if the tooth was from the same juvenile. Therefore, the final MNI of the Feature 9 Burial is four, with two adults and two juveniles.

Indications of sex of the two adult individuals were based on the mandible, several cranial fragments, and disparity in size of the femoral fragments. The mandible displayed a gonial angle slightly more obtuse than 90 degrees, and a square chin with a

Figure 9: Right Scapula and Left Tibia of Juvenile 1 of Feature 9 Burial

prominent mental eminence at the midline. The gonial angle was everted, and had lines of heavy muscle attachment. When seriated with other mandibles from the collection, the mandibular dimensions placed this individual as a male. Observed cranial fragments were a left temporal bone, frontal fragment, and reconstructed fragments of the occipital and right parietal bones. The left temporal bone had a small mastoid process with minimal inferior projection. The zygomatic root of this temporal bone ended anterior of the EAM. The frontal fragment of the glabella and medial portions of both eye orbits exhibited gracile brow ridges and a weak, smooth glabella. Similarly, the occipital fragment displayed weak nuchal crests with unpronounced muscle attachment sites. Although from numerous cranial fragments, this suite of cranial dimensions indicates a female individual. The disparity in size of the two femoral shaft fragments also could indicate one male and one female individual. Thus, the two individuals of the Feature 9 Burial most likely represent one male individual and one female individual.

Age estimations of the juvenile material were based on the aforementioned size comparison with an historic forensic case and the dental eruption sequence of the mandible. As discussed previously, the size of the left scapula and left tibia place Juvenile 1 in the age range of five to seven years of age, perhaps younger. The juvenile mandible had fully erupted permanent first molars, a partially erupted left permanent second molar and left permanent first premolar, as well as both deciduous second molars (see Figure 10). The first permanent molars complete eruption by the age of eight, while

Figure 10: Mandible of Juvenile 2 of Feature 9 Burial

the second molars begin to erupt around ten to eleven years. The root apices of the left permanent second molar are not fully formed again indicating an age of ten to eleven. The upper third of the crown of the left permanent first premolar is visible. This tooth begins erupting around age nine and completes eruption around age eleven. Lastly, the presence of both deciduous second molars further correlates the age range of Juvenile 2 at nine to eleven years because these deciduous teeth are lost around age eleven. The right deciduous molar is actually unattached from the mandible because the roots were fragile due to initial resorption and broke. Underneath the root fragments still retained in the mandible, the permanent second premolar is just beginning to erupt through the bone. The eruption of this tooth begins in the aforementioned age range of nine to eleven. Therefore, Juvenile 2 is placed at nine to eleven years of age.

Though not possible to determine between the male or female individuals of the Feature 9 Burial, one adult age estimation could be made for this burial. The medial end of a right clavicle was recovered. The sternal end of this clavicle was unfused, and no epiphysis was collected. Generally, this stage of clavicular development is seen in males less than 25 years of age and females less than 23 years of age (Bass 1995:136). Other indications of adult age were the presence of third molars with complete root apices, one of which had an extreme carious lesion of the occlusal surface.

<u>Feature 11 Burial</u>

Feature 11 contained one adult individual, as no elements duplicated. Since the remains were exclusively above the pelvic girdle, estimation of sex was based on dimensions of the mandible and cranial fragments. The mandible is large and thick with a square chin. The gonial angles were damaged, so no observations could be made. A frontal fragment of the right medial superior eye orbit displayed a prominent brow ridge.

The right zygomatic is large and robust in size with a rugous malar tubercle and pronounced muscle attachment sites. The left zygomatic is also large in size, but postmortem damage precluded any observations of the malar tubercle or muscle attachments. From these observations, this individual was classified as male. Other than comparable size to males, the postcranial elements do not provide any sexually diagnostic characteristics. The rugosity of the mandible, maxilla, and zygomatics and indications of third molars placed this individual as an adult.

Isolated Remains

Skeletal material was recovered from other units on Moho Cay. These remains were isolated finds and were not thought to represent discrete burials. The findings of the skeletal remains are given below by the unit in which they were found.

Unit 1

Remains collected from Unit 1 included a left patella, a maxillary molar, and fragments of a vertebra and an unidentified long bone. This skeletal material represents one individual.

Unit 2e

The only skeletal material recovered from Unit 2e was a mandible fragment and left third molar crown. The mandible contained the left second molar and the roots of the unattached left third molar. Though the gonial angle was slightly damaged, observations of sexually diagnostic features were made. The gonial angle approximated 90 degrees, flared laterally, and had heavy muscle attachment sites. These features are indicative of a male individual. The proximity of Unit 2e, north of Unit 2b, to Burials 3 and 4 and the Feature 9 Burial was not enough to associate the fragment with any of these burials. Therefore, the remains likely represent one adult male individual.

Unit 4

Skeletal material from Unit 4 was restricted to the isolated find of a mandible fragment seen eroding from the surface (McKillop 1980:29). The fragment was the left coronoid process of the ascending ramus. This fragment represents one individual.

Units 6 and 6a

Two human skeletal fragments were collected from a midden comprised mainly of manatee bones and various shells (McKillop 1984). In Unit 6, a tibial shaft fragment was removed at 10 to 20 cm depth, and one maxillary molar was recovered from Unit 6a at 40 to 50 cm depth. This skeletal material represents one individual.

Unit 9b

Fragments of a left femur and left tibia were collected from Unit 9b. The leg bones are fairly gracile, perhaps indicating a female individual; however, the gracility of the two long bones is not sufficient to make a definitive sex estimation. This skeletal material represents one individual.

Unit 10

While excavating Unit 7a, human remains were observed farther offshore to the west. "The bones were loosely held in the underlying soil, and some had recently been washed out" (McKillop 1980:39). Three long bone fragments were collected from this area, designated as Unit 10, when exposed by the receding tide. The fragments included portions of a left humerus, left femur, and right tibia. These remains represent one individual.

Unit 11

Cranial fragments were encountered in Unit 11. The three cranial fragments, including one from the occipital bone, were thin and fragile. These cranial fragments represent one juvenile individual.

Unit 15

Fragmentary remains in Unit 15 included portions of the cranium, a femoral shaft and head, the right third metacarpal, a fibula, and a complete right patella, as well as several unidentified fragments. These remains represent one individual.

Unit 21

Human skeletal material was revealed during the cleaning of the north wall of Unit 21 for a profile drawing (McKillop 1980:48). The isolated find of a fragment of the left humerus was the only recovered bone. The small size of the humeral head and proximal shaft was comparable to the humerus of the female in Burial 2a. However, no definitive sex estimation could be established on this limited observation. Therefore, the humerus fragment represents one individual.

Summary

The skeletal material excavated from Moho Cay, Belize, in 1979 includes remains from eight discrete burials and nine other archaeological units. The MNI of the collection is 27 individuals, with 20 adults and seven juveniles (see Table 1). Estimations of sex and age were performed according to criteria set forth by Bass (1995) and Buikstra and Ubelaker (1994). Those findings are presented in Tables 2 and 3. Similarly, no age estimations of adults were given due to insufficient skeletal material, specifically the absence of any pubic symphyses and the poor preservation of the auricular surfaces of the hip bones.

Table 1 shows that five of the discrete burials were multiple interments. The number of individuals in these multiple burials ranged from two to four. Chase and Chase (1996) suggested that interments of multiple individuals at Caracol might signify family burial areas. While multiple individual interments were encountered at Moho Cay, the conclusion of family burial areas can not be reached at this preliminary stage of analysis.

Table 1: MNI of Moho Cay Skeletal Material

Feature	Individuals	Adult	Juvenile
Burial 1	3	1	2
Burial 2a	1	1	-
Burial 2b	3	3	-
Burial 3	2	1	1
Burial 4	3	2	1
Burial 5	1	1	-
Feature 11 Burial	1	1	-
Feature 9 Burial	4	2	2
Isolated Remains	9	8	1
Total MNI	**27**	**20**	**7**

Sex estimations for the entire collection are presented in Table 2. Of the 27 individuals buried at Moho Cay, seven were classified as males, and five as females. The 15 individuals of undetermined sex subsume the seven juveniles for which sex determination cannot be achieved

Table 2: Sex Estimates

Males	7
Females	5
Undetermined	15

The age estimations of the juveniles are presented in Table 3.

Table 3: Age Estimates of Juveniles

Burial 1	
Juvenile 1	6-10 years
Juvenile 2	3-5 years
Burial 3	
Juvenile 1	Undetermined
Burial 4	
Juvenile 1	5-8 years
Feature 9 Burial	
Juvenile 1	5-7 years
Juvenile 2	9-11 years
Isolated Fragments	
Juvenile 1	Undetermined

Ages of the juveniles of Moho Cay ranged from three to 11 years. Dental development and tooth eruption sequence were used to determine the ages of Juvenile 1 of Burial 1, Juvenile 2 of Burial 1, and Juvenile 2 of the Feature 9 Burial. Juvenile 1 of the Feature 9 Burial was aged at five to seven years by size comparison of the tibia and scapula with an historic forensic case of a five to seven-year-old of the FACES lab collection. Juvenile 1 of Burial 4 was determined to be five to eight years old due to lack of fusion of pelvic elements and epiphyseal union of the femoral head along with size comparisons of the corresponding elements of the historic juvenile material. Juvenile remains from Burial 3 and Unit 11 were not sufficient enough to make age estimations.

TAPHONOMY

Taphonomy is the study of natural or human processes affecting bone and other materials after death. In order to observe taphonomic changes in bone, features such as color, shape, and surface detail of the bone must be scrutinized. The most common taphonomic signatures are discoloration caused by soil and marks of insect and animal activity. Examples of taphonomic changes induced by human activity are cremation, defleshing cut marks, and excavation damage (Buikstra and Ubelaker 1994). Taphonomic examination of skeletal remains is necessary in order to distinguish between perimortem events and postmortem trauma or environmental processes. Natural processes and insect or animal activity were responsible for the majority of taphonomic changes in the Moho Cay collection.

Discoloration

Depositional environments may contain bacteria, plants, and minerals that will alter the color of bones (Buikstra and Ubelaker 1994). The entire bone may change color, or a stained area will develop on the outer surface of the bone. Exposure to sunlight will have the inverse effect, bleaching, whereby the bone will lose its ivory color and become more off-white. Several bones of multiple units from Moho Cay have become black (see Figure 11). The discoloration ranges from isolated stains to the entire fragment being black. Fragments of the right humerus of Burial 4, left femur from Burial 2a, and the right tibia from Burial 3, as well as the plantar surface of the left talus of Burial 5, all exhibit varying degrees of black discoloration. The black discoloration of the exterior surfaces of chert artifacts from Moho Cay and from Wild Cane Cay was

Figure 11: Examples of Bone Discoloration
Left: Burial 4 Right Humerus (anterior view) Top Center: Burial 5 Left Talus (plantar view) Bottom Center: Burial 3 Right Tibia (lateral view) Right: Burial 2a Left Femur (posterior view)

attributed to submersion in permanently waterlogged salty soil of the deeper excavation levels (McKillop 2003). Interestingly, the right tibia of Burial 3 is black on both the inner and outer surfaces of the cortical bone, yet the bone in between the superficial layers is not discolored.

<u>Insect and Animal Activity</u>

Changes may occur to bone surfaces due to insect and animal activity. Tooth marks of rodent gnawing and small incisions caused by burrowing animals are frequently observed on human remains. For example, pairs of parallel incisions were viewed on several fragments from Burial 11 (see Figure 12). Bones that exhibited these shallow marks were the right radius, humeri, right brow ridge, and several other unidentified fragments. The marks of the radius and humeri were examined under a Nikon SMZ 800

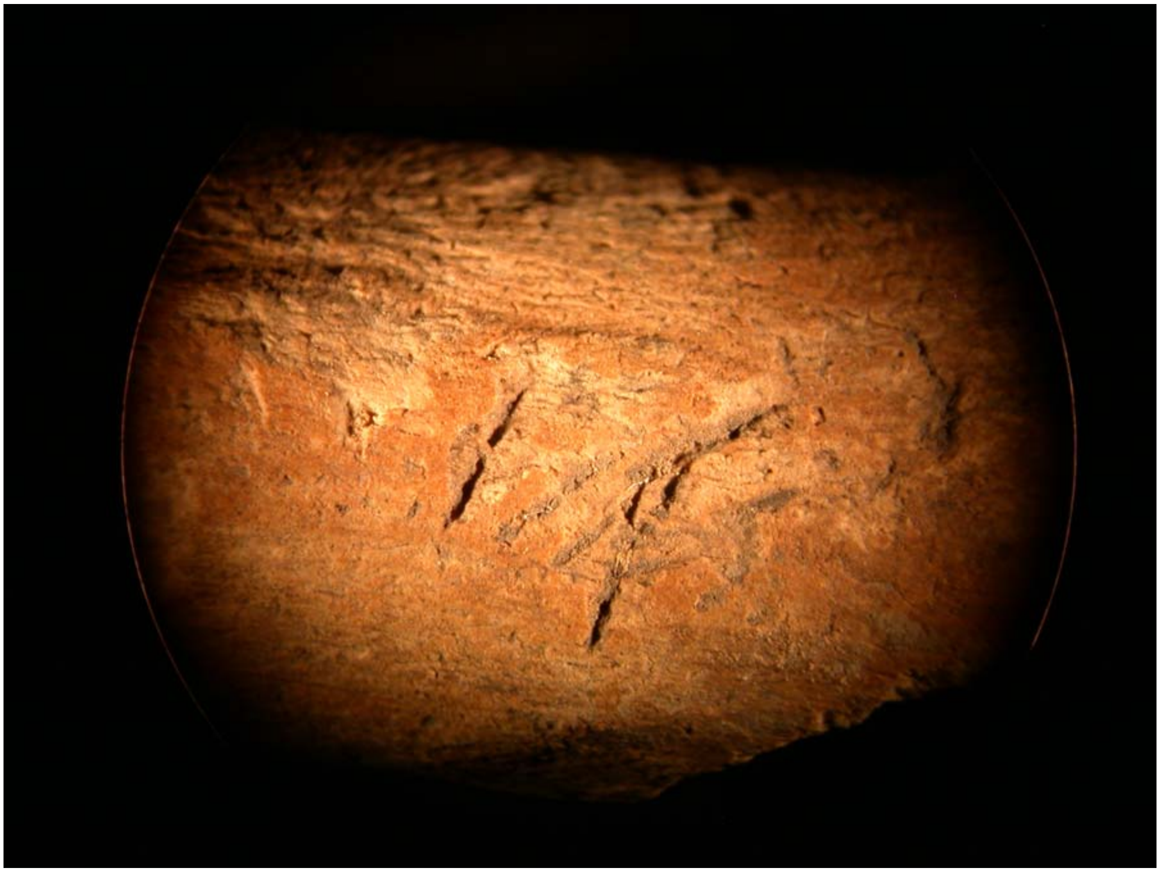

Figure 12: Microscopic View of Rodent Marks
Right Radius from Feature 11 Burial (Image Magnification 8x)

reflected light stereoscopic zoom microscope to rule out the possibility of human involvement. Other evidence of taphonomic damage attributed to animal activity is a circular hole seen in the right tibia of Burial 1 and the right femur of Burial 2b.

Excavation Damage

Archaeologists will sometimes damage bone with their excavation tools. This damage usually occurs accidentally just prior to the discovery of the bone. One cranial fragment from the Feature 9 Burial displays this type of postmortem trauma to the ectocranial surface (see Figure 13). The light color of the area of damage precludes the assessment of prehistoric trauma.

Figure 13: Excavation Damage to Cranial Fragment from Feature 9 Burial

SKELETAL INDICATORS OF DIET AND HEALTH

Physical anthropologists examine skeletal pathology in order to elucidate connections between the health, disease, and activities of individuals in a population. While not all ailments leave skeletal markers, the study of the skeletal signatures of diseases can provide insight into the health status and occupational stresses of an individual. Health at the level of the community may be evaluated when a representative sample of a population is available for study. Pathologies normally assessed in an osteological examination include, but are not limited to, osteoarthritis, degenerative joint disease (DJD), periostitis, cribra orbitalia, and porotic hyperostosis.

All remains from Moho Cay were inspected for gross signs of pathologies. The observed pathological conditions are listed by disease with an explanation of the frequency of occurrence in the population.

Osteoarthritis

Osteoarthritis is the breakdown of articular surfaces of joints. This deterioration of skeletal articulations is often caused by normal "wear and tear" placed upon the joints throughout the lifetime of an individual. Characteristic changes of osteoarthritis include bony lipping, porosity of the joint surface, and eburnation. Bony lipping is the growth of osteophytic spicules along the joint edges. Porosity is identified as symmetrical pits in the cortical bone of the joint surface. Eburnation refers to areas of the joint where the cartilage has been destroyed and the bone appears polished or shiny due to chronic friction of bone on bone (Buikstra and Ubelaker 1994).

In Burial 1, the adult male has evidence of osteoarthritis in two contiguous lumbar vertebrae and the left patella (see Figure 14). The bodies of the two vertebrae have

Figure 14: Lumbar Vertebrae Showing Osteoarthritic Lipping
Left and Center: Burial 1 Male, Right: Burial 5 Male

moderate osteophytic lipping of the superior and inferior margins of the body. The patella displays a small amount of lipping on the edge of the medial facet. Due to damage to the inferior half of both patellar facets, the degree and severity of this lipping could not be fully assessed.

Another case of osteoarthritis of the lumbar vertebrae was seen in the male individual of Burial 5 (see Figure 14). Mild osteophytic lipping was observed in the only lumbar vertebra recovered in this burial. Similar to the lumbar vertebrae from the male in Burial 1, lipping occurred on the superior and inferior margins of the body. However, the degree of lipping of the Burial 5 individual is less significant than that of the individual from Burial 1.

Individual 2 of Burial 4, also a male, displays slight lipping of the bodies of the second, third, and fourth cervical vertebrae (see Figure 15). The lipping of these vertebrae occurs along the ventral and lateral edges of the bodies. Osteoarthritic lipping

Figure 15: Cervical Vertebrae Showing Lipping
Four Leftmost: Individual 2 of Burial 4, Rightmost: Individual 1 of Burial 4

and compression were seen in two other cervical vertebrae fragments of this individual. Compression of the bodies occurred in an anterior-posterior direction. Individual 1 of Burial 4, a female, shared similar pathological morphology in the lipping and compression of one cervical vertebral body. These cases of osteoarthritis, especially in the vertebrae, may be typical age-related changes of the joint surfaces. Of the males, all three for which vertebrae were recovered had osteoarthritic lipping of the vertebrae.

<u>Degenerative Joint Disease</u>

Degenerative joint disease (DJD) is a form of osteoarthritis in which bones display varying degrees of lipping, pitting, and eburnation of the joint surfaces as a result of injury, trauma, and/or chronic occupational stress (Bridges 1992). No single cause of DJD has been determined. Occupational stress from lifestyle activities should cause asymmetrical wear of the joints, whereas age-related changes of articular surfaces should affect both sides equally. As there are multiple causes of DJD, individuals of all ages are affected by this condition.

In Burial 2a, several examples of DJD were found. The female's right patella exhibited severe lipping of both facets superiorly and the medial facet inferiorly, as well as coalesced pitting on both facets (see Figure 16). In the right femur, slight lipping of

Figure 16: Right Patella of Burial 2a Female
Showing Lipping and Pitting (Posterior View)

the condyles can be seen, but is mild in comparison to the severe lipping and pitting of the corresponding patella. Thus, the restriction of severe DJD to the patella suggests that this condition resulted from an injury or trauma to the knee. The Burial 2a female also displayed slight lipping of the medial surface of the proximal left ulna and the trochlea of both humeri.

Similarly, the larger right ulna of Burial 2b and a left ulna from the Feature 9 Burial showed evidence of slight lipping of the olecranon and coronoid processes (see Figure 17). The ulna from Burial 2b has a ridge of bone built up from the medial side

Figure 17: Ulnae Showing Signs of DJD
Top to Bottom: Feature 9 Burial, Burial 2a, Burial 2b

extending to the middle of the trochlear notch. Evidence of DJD in the elbow joints of these individuals may indicate high amounts of activity-related stress were placed on these joints. Possible activities that may be responsible for the articular deterioration of the elbow joints are grinding corn in metates, fishing, and canoeing. Unfortunately, the poor preservation of the long bones resulted in a multitude of shaft fragments without proximal or distal ends. Therefore, observations of DJD were limited and no side comparisons of the same element could be made.

<u>Periostitis</u>

Periostitis is the inflammation of the outer layer of bone, known as the periosteum. The inner layer of the periosteum will respond to an acute or chronic injury or infection by forming a sleeve of woven bone on the outer surface (White 2000). Periostitis may be restricted to a single bone when a localized periosteal lesion develops in response to bacterial infections. Localized infections of the periosteum can result from a bruise or cut to the surrounding tissue, as well as a fracture to the bone. Periostitis can also affect several bones simultaneously in the case of systemic bacterial infections, such as streptococcus or staphylococcus. While periostitis can have an effect on all long bones, the tibiae are the most frequently affected (Steele and Bramblett 1988).

Cases of periostitis were limited to one burial. Several long bone fragments of Burial 2b showed evidence of periostitis. These fragments included the shafts of four tibiae, one fibula, two femora, and two ulnae. Though not possible to distinguish which individuals displayed this infection, at least two individuals are represented by the bones that display periostitis. The etiology of these cases of periostitis cannot be pinpointed since periosteal infections are a common bone infection found in skeletal remains. However, the occurrence of periostitis in numerous long bones may indicate at least one individual suffered a systemic bacterial infection.

<u>Harris Lines</u>

In addition to gross observation of pathologies, x-rays were taken in order to detect Harris lines. Harris lines result from chronic periods of nutritional stress or disease when longitudinal growth of the long bones temporarily ceases. Harris lines will appear as opaque transverse lines across the long bones in x-rays (Steele and Bramblett 1988). These radiographic skeletal markers serve as another indication of an individual's health and access to nutritional food resources during childhood. However, "because normal processes of remodeling can obliterate these deposits, the strength of association between the presence of Harris lines and stress remains equivocal" (Glassman and Garber 1999:126).

X-rays were taken of all tibial fragments of the collection to detect the presence or absence of this condition. Fifteen tibial fragments from ten individuals were x-rayed in the anterior-posterior plane at 40 inches from the cartridge. The voltage was 60 kilovolts per 0.5 seconds with the tube current at 50 milliamperes.

Visual inspection of the roentgenograms revealed no incidences of Harris lines. One possible explanation for the absence of this marker is that these ten individuals had adequate nutrition and did not suffer from chronic periods of nutritional stress or disease during childhood. Alternatively, the tibiae representing eight adults may have remodeled over time and obliterated any evidence of this pathology. Another reason for the lack of Harris lines could be that the tibial shafts did not always include the proximal region. Steele and Bramblett (1998) state that Harris lines are most obvious in the proximal tibia even though they occur uniformly throughout the long bones.

Overall, the Moho Cay sample did not exhibit a high frequency of gross or radiographic skeletal pathologies. The most common skeletal pathologies were degenerative conditions affecting the joints, such as the vertebra, elbow, and knee. No cases of cribra orbitalia or porotic hyperostosis, which are the result of iron-deficiency anemia, were observed in the remains. The lack of pathologies caused by nutritional stresses indicates that individuals of Moho Cay had a stable food supply that provided sufficient nutrition for normal growth and development. The ample diet of both agricultural and aquatic or marine food resources afforded the Moho Cay Maya better health than their inland counterparts.

The degenerative pathologies may also be a result of the coastal environment in which these individuals resided. Occupational stresses placed upon the joints may have been caused by long-term lifestyle activities, such as canoeing, fishing, and the processing of corn. Chronic stress associated with these intensive actions would account for the more common occurrences of osteoarthritis and DJD in this population.

Stature

Another skeletal indicator of health is the living stature of an individual. Living stature estimations can be derived from measurements of the maximum lengths of various long bones (Bass 1995). Though stature is genetically influenced, achievement or failure to reach a normal adult height of a population may reflect an individual's ability to reach his or her full growth potential as determined by access to food resources during childhood.

Only one stature estimation could be made from the entire collection due to the fragmentary nature of the remains. The left humerus from the female of Burial 2a was the only complete long bone (see Figure 18). This bone, fractured into two segments, was reconstructed and measured to have a maximum length of 29.7 cm. The stature formula for the left humerus reported by Genovese (1967) for Mesoamerican females was utilized to derive this individual's height. The height of the female of Burial 2a was estimated to be 156 cm, which is approximately 5’1 ½”. Danforth (1994) presented the mean statures of females at six Late Classic sites as ranging from 149.2 to 153.9 cm.

Figure 18: Left Humerus of Burial 2a Female

Therefore, this female reached a normal adult height for a Maya woman. As an indicator of childhood growth and nutrition, achieved adult stature of this individual indicates that she had access to an adequate supply of food during childhood. Since no other stature estimations could be generated, comparative analysis of stature within the collection could not be conducted.

DENTAL PATHOLOGY AND ATTRITION

The oral environment, specifically the teeth, provides a direct record of an individual's diet and health. The chemical composition of the food consumed can have deleterious effects on the dentition causing dental wear and pathologies, such as carious lesions, abscesses, and calculus. Periods of disease and nutritional stress can also be indicated in the dentition through lines of enamel hypoplasia. These lines represent a quiescent episode of enamel formation.

All teeth of the Moho Cay collection were grossly examined for signs of dental pathology. A total of 141 teeth representing 13 individuals were inspected. Ten teeth were omitted from the study because they were unerupted or impacted teeth which could not exhibit any pathologies. Of the 131 teeth analyzed, there were 26 incisors, 15 canines, 31 premolars, and 59 molars. Systematic analysis of the dental remains focused on caries, calculus, abscesses, enamel hypoplasia, antemortem tooth loss, and the degree of attrition. Observations of frequency of dental pathology and level of attrition were recorded to assess the relationship between those traits and tooth class. Chi-square analyses were performed to test for an association between tooth class and dental pathology, as well as level of attrition.

Caries

Carious lesions of the dentition are observable areas of enamel breakdown and destruction often in the form of small holes or pits. Posterior teeth are more prone to developing caries, and the maxillary teeth show higher frequencies of caries than the mandibular teeth (Patterson 1984). This dental pathology is common among prehistoric agricultural populations, such as the Maya, due to the carbohydrate-rich diet.

Nineteen teeth (14.5%) from eight individuals of Moho Cay displayed carious lesions. Those teeth affected by caries were one canine and 18 molars (see Figure 19).

Figure 19: Example of Occlusal Carious Lesion
Mandibular Molar of Individual 2 of Burial 4

Caries occurred on all surfaces of the teeth and were present in both deciduous and permanent teeth (see Figure 2).

<u>Calculus</u>

Calculus is the accretion of calcified plaque on the non-occlusal surfaces of the teeth. Calculus was present on 81 (61.8%) of the teeth representing eight individuals. The classes of teeth with calculus were nine incisors, eight canines, 21 premolars, and 43 molars. The degree of dental calculus formation ranged from small amounts to severe amounts where over 75 percent of the buccal surfaces were covered (see Figure 20).

Figure 20: Examples of Calculus on Buccal Surfaces of Left Premolar and Molars of Individual 2 of Burial 4

Abscess

In cases of extreme dental wear and/or caries, an abscess of the tooth and root may occur. An abscess will cause an inflammation of the surrounding tissues in the pulp chamber. Ramifications of this pathology extend beyond the dentition to a larger suite of health complications, such as infections in the bone or blood and alveolar bone resorption (Buikstra and Ubelaker 1994).

A total of three abscesses were present in three individuals of the collection (see Figure 21). Abscesses were seen on one premolar and two molars. Interestingly, the three abscesses occurred exclusively on maxillary teeth. Saul and Saul (1991) noted that dental abscesses in the Cuello population were present in six maxillae versus one mandible.

Figure 21: Abscess of Molar of Individual 2 of Burial 4

<u>Enamel Hypoplasia</u>

As enamel formation is cumulative throughout childhood, the enamel of an individual acts as a record of juvenile development. Disturbances, such as malnutrition and infectious disease, appear on the tooth crown as transverse lines of enamel hypoplasia. Hypoplastic lines arise when enamel formation ceases during chronic periods of nutritional stress to the individual (Buikstra and Ubelaker 1994).

Enamel hypoplasias were observed in several teeth of Juvenile 1 from Burial 1. This juvenile was the only individual to exhibit this dental pathology. Three lines of enamel hypoplasia were easily viewable on four maxillary incisors and one canine (see Figure 22). Thus, this juvenile suffered three major events of severe nutritional stress or disease during his or her lifetime. Two mandibular incisors from the same juvenile each displayed one line of enamel hypoplasia.

Figure 22: Examples of Enamel Hypoplasia
Four Maxillary Incisors and Canine (far right) of Juvenile 1 of Burial 1

<u>Antemortem Tooth Loss</u>

Antemortem tooth loss is the result of some combination of caries, calculus, abscess, and/or heavy attrition. Caries are the leading factor of antemortem tooth loss in early adulthood, while tooth loss initiated by heavy attrition leading to abscess and infection is generally a problem in older individuals and in populations with high amounts of dietary grit (Ortner and Putschar 1985).

One or more teeth normally present in the dentition were missing from three individuals of the Moho Cay collection (see Figure 23). The missing teeth may be congenitally absent, lost prior to death, or even extracted. The female individual of Burial 2a did not have mandibular third molars or the right first molar of the mandible. The third molars are the most frequently missing teeth of all of the dentition (Bass 1995). Congenital absence of the third molars was determined after an x-ray was taken of the mandible and no wear facet was present on the distal surface of the left second molars. However, minute stippling was observable at the juncture of the body and the ascending

Figure 23: Examples of Antemortem Tooth Loss
Top: Maxilla Fragments of Feature 11 Burial
Bottom: (Left to Right) Mandibles of Burial 2a and Individual 1 of Burial 4

ramus of the mandible. Also, the left second molar was extremely worn and the right second molar was lost postmortem and not recovered. These characteristics limit the conclusion of congenital absence of the third mandibular molars. The right first molar of the female of Burial 2a, however, was lost antemortem. Although the alveolar bone has fully remodeled, a contact facet on the distal surface of the adjacent premolar was apparent.

Two maxilla fragments from the male of the Feature 11 Burial are missing the first right molars (see Figure 23). The alveolar bone showed signs of remodeling in both tooth sockets. The cause of the missing molars, either loss or extraction, cannot be determined.

The mandible of Individual 2 of Burial 4, classified as a female, is missing six teeth of the mandibular arcade (see Figure 23). Both of the right incisors, the right first molar, and all of the left molars had been lost. While the alveolar bone of the right first molar had remodeled, the bone from all of the other teeth still showed signs of remodeling. The second right molar has a mesial wear facet indicating the first molar was present, but lost antemortem. Again, the reason for the absence of the teeth is not apparent. However, the high number of absent teeth and the presence of a type of filling in the socket of the left second molar may indicate intentional extraction of some teeth was performed.

<u>Attrition</u>

Attrition is the natural wearing down of the occlusal surfaces of the teeth. The degree of wear derives from the diet and can negatively impact dental health by increasing the chances for development of carious lesions and abscesses. The coarser the foods consumed, the higher the degree of wear (Buikstra and Ubelaker 1994). Attrition often is successfully used as an aging technique of archaeological collections (Lovejoy 1985; Walker et al. 1991). However, in the Maya area, the practice of eating stone-ground corn exacerbates the wear of the teeth that may be more directly linked to increasing age in other populations. As such, aging the Maya by dental wear would lead to overestimations of age. Therefore, the level of attrition of each tooth was recorded, but no age approximations were made.

Level of attrition was recorded as low, moderate, or high. Low attrition subsumed those teeth with little to no wear and those teeth with minimal, pinprick sized dentine exposure. Moderate attrition indicated the occlusal surface still retained some topography with small patches of noncarious dentine exposure present or the surface was flat with minimal dentine exposure (see Figure 24).

Figure 24: Example of Moderate Attrition
Left Maxilla Fragment of Feature 9 Burial

High degree of attrition was noted as a large patch of dentine exposure with a small rim of enamel or several large patches of dentine exposure in which more than half of the occlusal surface was affected (see Figure 25).

Figure 25: Example of High/Severe Attrition
Right Maxilla Fragment of Individual 1 of Burial 4

Of the 13 individuals inspected, all had a combination of low to moderate dental wear (see Appendix). Eight individuals displayed a high degree of attrition in one or more teeth. Juvenile 2 of Burial 1 had high wear of the deciduous incisors (see Figure 2), while Juvenile 2 of the Feature 9 Burial (see Figure 10) showed high wear on the deciduous molars. The Burial 2a female had high attrition to two mandibular molars and one incisor, whereas the adult of the Feature 9 Burial displayed high wear on the left third maxillary molar affected by a carious lesion. The Burial 1 male also displayed high attrition exclusively in one mandibular molar. Individual 2 of Burial 4 (male) had high attrition on one incisor, one canine, and two molars. The Feature 11 male had high attrition on one incisor, one canine, and one molar. Individual 1 of Burial 4 (see Figure 25) displayed the most extreme attrition in the collection. High attrition of this female's dentition was seen in three incisors, three canines, three premolars, and one molar.

Statistical Analyses

The results of the analysis of dental pathologies, including caries, calculus, and abscess, are presented in terms of frequency in order to evaluate the relationships between the observed trait and tooth class. Results are also presented for the relationships between the severity of attrition and tooth class.

As a supplement to the qualitative analysis of the presence of dental pathology and severity of attrition, the occurrence of these traits per tooth class were statistically analyzed using two-way tables and Chi-square. Additionally, the relationship between frequency of dental pathology and level of attrition was analyzed specific to each class of tooth.

Dental Pathology

In this study, dental pathologies occurred as caries, calculus, abscesses, and enamel hypoplasias. Enamel hypoplasias were restricted to seven teeth of one juvenile and were not included in the statistical analyses. The diet is the main contributing factor to the development of carious lesions, calculus, and abscesses.

In the Moho Cay collection, 66.4% (n=87) of the teeth showed evidence of one or more of these pathologies (see Table 4). Since pathologies were observed on deciduous and permanent dentition, teeth from both were included in the analyses. Caries were observed in 6.7% of the canines and 30.5% of the molars. No caries were detected on the incisors or premolars. Calculus was the most ubiquitous dental pathology of the collection. Calculus affected all classes of teeth with 34.6% of the incisors, 53.3% of the canines, 67.7% of the premolars, and 72.9% of the molars exhibiting calculus. The least common pathology to occur was an abscess. Only three abscesses were present in the entire collection. Abscesses were present only in one premolar (3.2%) and two molars (3.4%) of three maxillae.

Table 4: Number and Percentage of Dental Pathology Observations Per Tooth Class

		Tooth Class				
		Incisor	Canine	Premolar	Molar	Total (131)
Dental Pathology	Caries	0/26 (0%)	1/15 (6.7%)	0/31 (0%)	18/59 (30.5%)	19 (14.5%)
	Calculus	9/26 (34.6%)	8/15 (53.3%)	21/31 (67.7%)	43/59 (72.9%)	81 (61.8%)
	Abscess	0/26 (0%)	0/15 (0%)	1/31 (3.2%)	2/59 (3.4%)	3 (2.3%)

Level of Attrition

Level of attrition was assessed on all teeth of the collection. The level of attrition ranged from very little (classified as low) to high in which the majority of the occlusal surface was horizontally worn and exposure of dentine was substantial. Since attrition of all levels was observed on deciduous and permanent dentition, teeth from both were included in the analyses. All classes of teeth exhibited the three different degrees of attrition (see Table 5). Low attrition was seen in 40.5% (n=53) of the teeth. Moderate attrition was observed in 38.9% (n=51) of the teeth. High attrition was exhibited by 20.6% (n=27) of the teeth.

Some interesting patterns emerge from examination of level of attrition by tooth class. Premolars and molars have fewer incidences of high attrition than do incisors or canines. Premolars have the highest frequency of low attrition, while molars exhibited the highest incidence of moderate attrition. The frequency and percentage of level of attrition per tooth class is reported in Table 5.

Table 5: Number and Percentage of Attrition Level Observations Per Tooth Class

		Tooth Class				
		Incisor	Canine	Premolar	Molar	Total (131)
Level of Attrition	Low	9/26 (34.6%)	5/15 (33.3%)	17/31 (54.8%)	22/59 (37.3%)	53 (40.5%)
	Moderate	8/26 (30.8%)	5/15 (33.3%)	11/31 (35.5%)	27/59 (45.8%)	51 (38.9%)
	High	9/26 (34.6%)	5/15 (33.3%)	3/31 (9.7%)	10/59 (16.9%)	27 (20.6%)

Tooth Class

The results from the analysis of tooth class of the Moho Cay collection indicate that there is a relationship between tooth class and type of dental pathology (see Table 6). The obtained chi-square value closely approaches significance. Incisors exclusively had calculus. Canines mainly had calculus, with one cavity, while premolars mainly had calculus, with one abscess. Molars displayed caries and calculus, as well as two abscesses. Therefore, calculus occurred on all tooth classes, but the greater occurrence of calculus and other dental pathologies was seen on the molars.

Table 6: Tooth Class and Dental Pathology

		Tooth Class				
		Incisor	Canine	Premolar	Molar	Total
Dental Pathology	Caries	0	1	0	18	19
	Calculus	9	8	21	43	81
	Abscess	0	0	1	2	3
	Total	9	9	22	63	103

X^2=12.51 0.10 < p < 0.05 df = 6

Table 7 shows that there is no significant relationship between tooth class and level of attrition.

Table 7: Tooth Class and Level of Attrition

		Tooth Class				
		Incisor	Canine	Premolar	Molar	Total
Level of Attrition	Low	9	5	17	22	53
	Moderate	8	5	11	27	51
	High	9	5	3	10	27
	Total	26	15	31	59	131

X^2=9.33 0.20 < p < 0.10 df = 6

Each class of tooth was analyzed separately to test the relationship between the type of dental pathology and level of attrition. Tables 8 through 11 display the results of these analyses.

Calculus was the sole pathology in nine out of 26 incisors and occurred most frequently on incisors with moderate and high attrition, with only one incisor having low attrition and calculus. Table 8 shows that there is no significant relationship between calculus and level of attrition in the incisors.

Table 8: Dental Pathology and Level of Attrition of the Incisors

		Dental Pathology	
		Calculus	Total
Level of Attrition	Low	1	1
	Moderate	4	4
	High	4	4
	Total	9	9

$X^2=2.00 \quad 0.40 < p < 0.35 \quad df = 2$

Eight out of 15 canines displayed at least one pathology in addition to level of attrition. One canine displayed multiple pathologies with a carious lesion and calculus. Table 9 shows that there is not a significant relationship between the type of dental pathology and level of attrition in the canines. In the canines, there are no abscesses and only one cavity. Calculus in the canines occurs almost equally in each level of attrition.

Table 9: Dental Pathology and Level of Attrition of the Canines

		Dental Pathology		
		Caries	Calculus	Total
Level of Attrition	Low	0	2	2
	Moderate	1	3	4
	High	0	3	3
	Total	1	8	9

X^2=1.42 $0.50 < p < 0.45$ df = 2

Twenty-one premolars out of a total of 31 showed at least one pathology in combination with a level of attrition. Premolars displayed no carious lesions and only one abscess. One maxillary premolar displayed both calculus and an abscess. Table 10 shows that there is no significant relationship between the type of dental pathology and level of attrition in the premolars. In this dental sample, there is an inverse relationship between calculus and level of attrition. With increasing attrition of the premolars, there is less incidence of calculus.

Table 10: Dental Pathology and Level of Attrition of the Premolars

		Dental Pathology		
		Calculus	Abscess	Total
Level of Attrition	Low	14	1	15
	Moderate	6	0	6
	High	1	0	1
	Total	21	1	22

X^2=0.49 $0.80 < p < 0.75$ df = 2

Forty-eight of the 59 molars showed a minimum of one pathology in combination with some level of attrition. Fifteen molars displayed multiple dental pathologies. Table 11 shows that there is not a significant relationship between the type of dental pathology and level of attrition in the molars. As with the premolars, there is an inverse relationship between attrition and calculus in the molars. An increase in dental wear on the molars decreased the occurrence of calculus. The relationship between caries incidence and attrition on the molars is interesting, in that about twice as many molars with moderate attrition have caries than with either low or high attrition. This finding indicates that attrition from low to moderate may contribute to an increase in cavities, but further attrition does not increase the incidence of cavities.

Table 11: Dental Pathology and Level of Attrition of the Molars

		Dental Pathology			
		Caries	Calculus	Abscess	Total
Level of Attrition	Low	5	13	1	19
	Moderate	9	21	1	31
	High	4	9	0	13
	Total	18	43	2	63

$X^2=0.74$ $0.95 < p < 0.90$ $df = 4$

In each class of tooth, the type of dental pathology shows no significant relationship with the level of attrition. The incisors displayed no cases of caries or abscesses regardless of level of attrition. Similarly, no abscesses occurred in the canines, and no caries were observed on the premolars. Molars displayed the greatest frequency of dental pathologies and the greatest variability in severity of attrition. The relationship between calculus and level of attrition per tooth class is interesting. In the incisors, calculus is most frequent with moderate or high attrition. In the canines, calculus occurred almost equally across all levels of attrition. For premolars, the incidence of calculus decreases as attrition increases. For the molars, the presence of calculus increases from low to moderate attrition, but then decreases from moderate to high attrition.

DENTAL MODIFICATION

Cultural modification of the dentition is commonplace in prehistoric populations and the Maya in particular (Glassman 1995; Milner and Larsen 1991; Saul and Saul 1997, 1991; Stewart 1953). Some modifications involve deliberate mutilation to the tooth crown, such as filing and drilling holes for inlays, both popular among the ancient Maya. These types of dental modifications were ornamental. By way of contrast, some habitual behaviors, such as pulling vegetable fibers through the teeth (i.e. basket production), can cause grooves in the tooth crown (Buikstra and Ubelaker 1994). Since the anterior dentition is the most noticeable visually, the incisors are the teeth most often modified (Bass 1995).

Filing

One individual from Moho Cay displayed intentional dental mutilation (see Figure 26). Individual 2 of Burial 4, a male, had filing of the distal edge of the right maxillary central incisor and canine. The right lateral incisor was not recovered, but may have possibly displayed this modification as well.

Figure 26: Examples of Dental Filing
(Left to Right) Right Maxillary Canine and Central Incisor
of Individual 2 of Burial 4

Dentistry

While cleaning a mandibular fragment from Individual 1 of Burial 4, evidence of prehistoric dental work was discovered (see Figure 27). All of the left molars were either

Figure 27: Mandible of Individual 1 of Burial 4
Showing Filling (on the right of photo)

lost or extracted antemortem. A filling has been placed in the crypt of the second molar, while the adjacent sockets of the first and third molars show signs of remodeling. The filling is distinct from the soil matrix in which the fragment was encased. The strong adherence of the filling to the bone is evident and restricted to one tooth socket. The filling was clearly placed in the mandible prior to the death of the female individual.

The mandibular fragment and filling were inspected under a Nikon SMZ 800 reflected light stereoscopic zoom microscope (see Figure 28). In this microscopic view

Figure 28: Microscopic View of Filling (Image Magnification 7x)

of the filling, the soil matrix can be seen as the distinct dark gray ring between the white filling and the surrounding bone. The soil matrix was gently cleaned from the bone, and the filling was carefully scraped to obtain a small sample. The filling is believed to be composed of a mixture of lime (calcium carbonate) with quartz or sand grains. Microscopic images were taken to show the composition of the filling (see Figure 29).

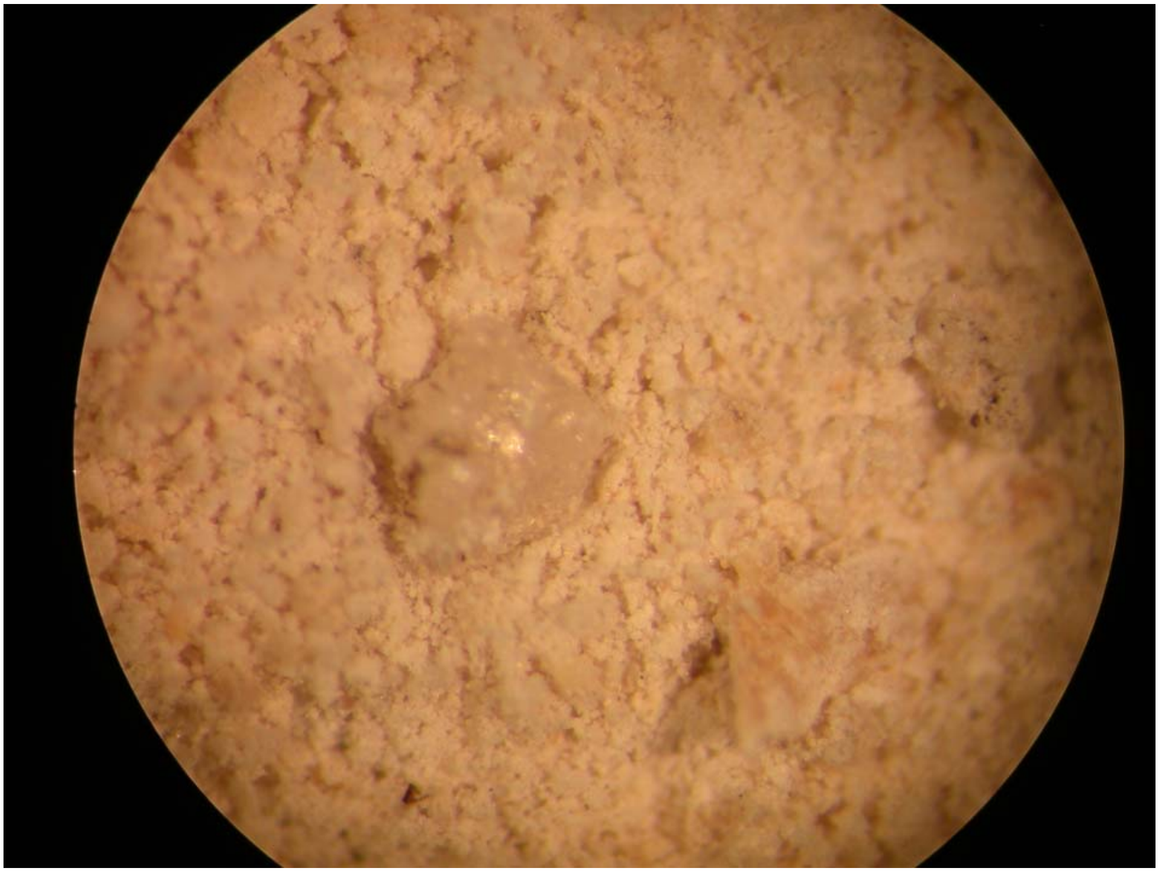

Figure 29: Microscopic View of Filling Composition Showing Sand Grains (Image Magnification 40x)

The processing of lime at Maya sites has been documented at the sites of Santa Cruz on Ambergris Caye and the Early Classic to Late Classic sites in Placencia Lagoon (Mazzulo and Teal 1994; MacKinnon and May 1990). Ancient uses of lime in Maya society included production for dietary consumption, corn processing, construction purposes, and for the sizing of bark paper (MacKinnon and May 1990). Perhaps, the filling indicates the Maya also employed lime as a dental remedy.

DISCUSSION AND CONCLUSIONS

Anthropological investigations of human skeletal remains can provide a glimpse into the life of prehistoric populations. Previous studies have yielded insight into the demography, health, diet, and status of specific populations. Researchers have demonstrated complex interplays of factors that influenced health patterns in Maya skeletons.

This research of Late Classic Moho Cay skeletal remains centered on developing a demographic profile and examining material for evidence of skeletal and dental pathology. A minimum of 27 individuals was recovered from eight discrete burials and nine other archaeological units in 1979. Seven individuals were classified as male, five as female, and sex was undetermined in 15 individuals. Age ranges of the juveniles were from three to 11 years of age. Age estimations of two of the seven juveniles were undetermined due to insufficient material.

Skeletal pathologies of the collection were few. Osteoarthritis occurred in the vertebrae of three males and one female. Degenerative joint disease occurred most often in the elbow joint as demonstrated by the slight lipping of ulnae from one male, one female, and one individual of unknown sex. The female of Burial 2a also displayed slight lipping of the distal humeri and moderate to severe lipping of the right patella.

Periostitis, perhaps caused by systemic bacterial infection, was limited to the long bones of at least two individuals of Burial 2b. No cases of cribra orbitalia or porotic hyperostosis were found during gross examination, nor were Harris lines detected in radiographic examination.

The occurrence of degenerative conditions is expected with an increase in age and excessive stress to the joints from occupational activities. The Moho Cay Maya males may have been more susceptible to osteoarthritis of the vertebrae than females, since all males for whom vertebrae were recovered had osteoarthritis versus one out of two females. No sex differences could be ascertained in the occurrence of DJD. However, the elbow joint was the most affected throughout the population. The degradation of this joint could be related to chronic subsistence activities of processing corn and intensive, repetitive stress placed on the elbow during canoeing and/or fishing. These findings would be expected given the coastal environment and trade activities of Moho Cay.

The lack of evidence of nutritional and disease related pathologies suggests that diet at Moho Cay was ample to avoid those metabolic disturbances of childhood growth that were seen in inland Maya sites. Obviously, the greater range of dietary resources afforded the Moho Cay Maya better health than the inland Maya with less access to marine resources. However, enamel hypoplasias were seen on the dentition of one juvenile. Juvenile 1 of Burial 1 showed three lines of hypoplasia on the anterior maxillary teeth and one line of hypoplasia on the mandibular incisors. This individual, aged six to ten provides the only evidence of nutritional stress and disease substantial enough to produce distinct dental markers.

Stature comparisons within the population were not possible due to the lack of more than one complete long bone. Stature was estimated for one individual, the female of Burial 2a, at 156 cm. The height estimation places this female above the mean statures given for females from six Late Classic sites by Danforth (1994). The range of mean stature for those sites is from 149.2 cm to 153.9 cm. The stature estimate of the Burial 2a female falls closer to the range of mean statures of Late Classic males (156.6 cm to 162.3 cm). Obviously, this female had adequate access to resources that enabled her to reach her full growth potential.

Dental examination of the Moho Cay individuals showed that juveniles and adults were equally susceptible to the development of carious lesions and calculus. Calculus was the most ubiquitous dental defect of the population, and may account for the low occurrence of caries. Calculus occurred in 81% of all teeth, while caries were observed on 19% of the teeth. These findings would corroborate Hillson's (1979) statement that the presence of calculus is inversely related to the presence of caries. Therefore, calculus served as a deterrent of the development of carious lesions in the Moho Cay Maya.

Abscesses occurred in only 2.3% of the teeth. This low frequency limits any conclusive statements of abscess as related to diet and health. However, it should be noted that the presence of abscesses was restricted to the maxillary posterior dentition.

Antemortem tooth loss was evident in three individuals. The male individual displayed missing maxillary first molars, while the females lost molars of the mandible. The female Individual 1 of Burial 4 also displayed antemortem loss of two mandibular incisors. Cause of antemortem tooth loss cannot be pinpointed to a specific factor.

Presence and severity of dental attrition were recorded for the Moho Cay Maya. No age estimations were calculated from tooth wear due to the corrosive nature of grit from stone-ground corn in the diet of the Moho Cay residents. Of the 13 individuals for whom teeth were assessed, eight displayed teeth with a high degree of attrition. High attrition was seen in deciduous incisors and molars and in all tooth classes of the permanent dentition.

The results of the statistical analyses revealed a relationship existed between tooth class and the type of dental defects. No significant relationship was found between tooth class and level of attrition. Some interesting patterns emerge from examination of level of attrition by tooth class. The posterior dentition has fewer incidences of high attrition than does the anterior dentition. Premolars have the highest frequency of low attrition, while molars have the highest incidence of moderate attrition.

The presence of intentional dental modification was seen in two individuals. Filing of the distal edges of a maxillary incisor and canine was observed in the male adult of Burial 4 (Individual 2). This decorative mutilation of the tooth surface is common in Maya populations. The interesting discovery of the collection occurred in the mandible of the female adult of Burial 4 (Individual 1). A filling had been placed in the tooth socket of the left second molar. The filling, composed of lime and sand, was restricted to this socket and did not interfere with the remodeling sockets of the adjacent first and third molars. This female had lost six mandibular teeth prior to death, which may indicate a high occurrence of infection of the oral tissues or intentional extraction. Whatever the cause of antemortem tooth loss in this individual, the filling presents a unique find of prehistoric dental work for curative reasons.

Overall, this study has found that the Moho Cay Maya had moderate dental health and good overall health since few cases of skeletal pathology were observed. Findings of this research are consistent with previous studies of coastal inhabitants (Glassman 1995; Glassman and Garber 1999). The diet of the Moho Cay Maya afforded them better health than inland counterparts at large cities. The overabundance of marine resources allowed the Moho Cay Maya to supplement their diet with foods higher in protein and rely less heavily on maize. The diverse diet may also account for the small incidence (19%) of caries, which are more frequent in populations with high carbohydrate intake.

The results of this study do not corroborate the hypotheses of Late Classic decline in public health that contributed to the ultimate collapse of the Classic Maya civilization. There are relatively few skeletal and dental pathologies. The one female stature estimation was in the normal height range. Therefore, the health of the Moho Cay Maya was quite good. Perhaps, coastal inhabitants of small island settlements were buffered by the diverse resources of the environment and not subject to the same health problems associated with high population.

WORKS CITED

Bass, William M. (1995) Human Osteology: A Laboratory and Field Manual, Fourth Edition. Columbia, MO: Missouri Archaeological Society.

Bridges, Patricia S. (1992) Prehistoric Arthritis in the Americas. Annual Review of Anthropology 21:67-91.

Buikstra, Jane E. and Douglas H. Ubelaker (1994) Standards for Data Collection from Human Skeletal Remains, Research Series No. 44. Fayetteville, AR: Arkansas Archaeological Survey.

Chase, Diane Z., and Arlen F. Chase (1996) Maya Multiples: Individuals, Entries, and Tombs in Structure A34 of Caracol, Belize. Latin American Antiquity *7*(1):61-79.

Coyston, Shannon, Christine D. White, and Henry P. Schwarcz (1999) Dietary Carbonate Analysis of Bone and Enamel for Two Sites in Belize. In Reconstructing Ancient Maya Diet, ed. Christine D. White, pp. 221-243. Salt Lake City, University of Utah Press.

Danforth, Marie E. (1994) Stature Change in Prehistoric Maya of the Southern Lowlands. Latin American Antiquity 5:206-211.

Danforth, Marie E. (1997) Late Classic Maya Health Patterns: Evidence from Enamel Microdefects. In Bones of the Maya: Studies of Ancient Skeletons, ed. Stephen L. Whittington and David M. Reed, pp. 127-137. Washington, DC. Smithsonian Institution Press.

Danforth, Marie E. (1999) Coming Up Short: Stature and Nutrition among the Ancient Maya of the Southern Lowlands. In Reconstructing Ancient Maya Diet, ed. Christine D. White, pp.103-117. Salt Lake City, University of Utah Press.

Genovese, Santiago C. (1967) Proportionality of Long Bones and Their Relation to Stature Among Mesoamericans. American Journal of Physical Anthropology 26:67-78.

Glassman, David M. (1995) Skeletal Biology of the Prehistoric Maya of Northern Ambergris Caye. In Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize, ed. Thomas H. Guderjan and James F. Garber, pp.73-93. San Antonio, TX, Maya Research Program.

Glassman, David M. and James F. Garber (1999) Land Use, Diet, and Their Effects on the Biology of the Prehistoric Maya of Northern Ambergris Cay, Belize. In Reconstructing Ancient Maya Diet, ed. Christine D. White, pp. 119-132. Salt Lake City, University of Utah Press.

Haviland, William A. (1967) Stature at Tikal, Guatemala: Implications for Ancient Maya Demography and Social Organization. American Antiquity 32:317-325.

Healy, Paul F., Heather McKillop, and Bernetta Walsh (1984) Analysis of Obsidian from Moho Cay, Belize: New Evidence on Classic Maya Trade Routes. Science 225:414-417.

Hillson, Simon W. (1979) Diet and Dental Disease. World Archaeology 11:147-162.

Larsen, Clark S. (1982) The Anthropology of St. Catherine's Island 3. Prehistoric Human Biological Adaptation. American Museum of Natural History Papers 57: 159-270.

Lovejoy, C. Owen (1985) Dental Wear in the Libben Population: Its Functional Pattern and Role in the Determination of Adult Skeletal Age at Death. American Journal of Physical Anthropology 68:47-56.

MacKinnon, J. Jefferson and Emily M. May (1990) Small-scale Maya Lime Making in Belize: Ancient and Modern. Ancient Mesoamerica 1:197-203.

Magennis, Ann L. (1999) Dietary Change of the Lowland Maya Site of Kichpanha, Belize. In Reconstructing Ancient Maya Diet, ed. Christine D. White, pp. 133-150. Salt Lake City, University of Utah Press.

Marquez, Lourdes, and Andres del Angel (1997) Height among Prehispanic Maya of the Yucatan Peninsula: A Reconsideration. In Bones of the Maya: Studies of Ancient Skeletons, ed. Stephen L. Whittington and David M. Reed, pp. 28-50. Washington DC, Smithsonian Institution Press.

Mazzullo, S. J., and C. S. Teal (1994) Mineralogic and Crystallographic Evidence of Lime Processing, Santa-Cruz Maya Site (Classic to Postclassic), Ambergris Cay, Belize. Journal of Archaeological Science 21:785-795.

McKillop, Heather (1980) Moho Cay, Belize: Preliminary Investigations of Trade, Settlement, and Marine Resource Exploitation. Master's thesis, Department of Anthropology, Trent University, University Microfilms, Ann Arbor.

McKillop, Heather (1984) Prehistoric Maya Reliance on Marine Resources: Analysis of a Midden from Moho Cay, Belize. Journal of Field Archaeology 11:25-35.

McKillop, Heather (1985) Prehistoric Exploitation of the Manatee in the Maya and Circum-Caribbean Areas. World Archaeology 16:337-353.

McKillop, Heather (1994) Ancient Maya Tree-Cropping: A Viable Subsistence Adaptation for the Island Maya. Ancient Mesoamerica 5:129-140.

McKillop, Heather (1996) Prehistoric Maya Use of Native Palms: Archaeobotanical and Ethnobotanical Evidence. In The Managed Mosaic: Ancient Maya Agriculture and Resource Use, ed. Scott L. Fedick, pp. 278-294. Salt Lake City, University of Utah Press.

McKillop, Heather (2003) The Classic Maya Trading Port of Moho Cay, Belize. In Archaeology of the Upper Belize Valley, ed. James F. Garber, Gainesville, University Press of Florida, In Press.

Milner, George R., and Clark S. Larsen (1991) Teeth as Artifacts of Human Behavior: Intentional Mutilation and Accidental Modification. In Advances in Dental Anthropology, ed. Marc A. Kelley and Clark S. Larsen, pp. 357-378. New York, Wiley-Liss, Inc.

Ortner, Donald J., and Walter G. J. Putschar (1985) Identification of Pathological Conclusions in Human Skeletal Remains. Smithsonian Contributions to Anthropology, No. 28. Washington DC, Smithsonian Institution.

Patterson, D. K. Jr. (1984) A Diachronic Study of Dental Paleopathology and Attritional Status of Prehistoric Ontario Pre-Iroquois and Iroquois Populations. Archaeological Survey of Canada. National Museum of Man Mercury Series, Paper No. 122. Ottawa: National Museums of Canada.

Peebles, C. S. (1977) Biocultural Adaptation in Prehistoric America: An Archaeologist's Perspective. In Biocultural Adaptation in Prehistoric America, ed. RL Blakely, pp. 115-130. Southern Anthropological Society, Proceedings No. 11. Athens, University of Georgia Press.

Reed, David M. (1999) Cuisine from Hun-Nal-Ye. In Reconstructing Ancient Maya Diet, ed. Christine D. White, pp. 183-196. Salt Lake City, University of Utah Press.

Saul, Frank P. (1972) The Human Skeletal Remains of Altar de Sacrificios: An Osteobiographic Analysis. Papers of the Peabody Museum of Archaeology and Ethnology, vol. 63, no. 2. Cambridge, Harvard University.

Saul, Frank P., and Julie M. Saul (1991) The Preclassic Population of Cuello. In Cuello: An Early Maya Community in Belize, ed. Norman Hammond, pp. 134-158. Cambridge, Cambridge University Press.

Saul, Frank P., and Julie M. Saul (1997) The Preclassic Skeletons from Cuello. In Bones of the Maya: Studies of Ancient Skeleton*s*, ed. Stephen L. Whittington and David M. Reed, pp. 28-50. Washington DC, Smithsonian Institution Press.

Steele, D. Gentry, and Claud A. Bramblett (1988) The Anatomy and Biology of the Human Skeleton. College Station, TX: Texas A&M Press.

Stewart, T. Dale (1953) Skeletal Remains from Zaculeu. In The Ruins of Zaculeu, Guatemala, vol. 1, ed. Richard B. Woodbury and Aubrey S. Trik, pp.295-311. Richmond, VA, United Fruit Co.

Stinson, Sara (1992) Nutritional Adaptation. Annual Review of Anthropology 21:143-170.

Storey, Rebecca (1999) Late Classic Nutrition and Skeletal Indicators at Copan, Honduras. In Reconstructing Ancient Maya Diet, ed. Christine D. White, pp. 169-179. Salt Lake City, University of Utah Press.

Walker, Phillip L., Gregory Dean, and Perry Shapiro (1991) Estimating Age from Tooth Wear in Archaeological Populations. In Advances in Dental Anthropology, ed. Marc A. Kelley and Clark S. Larsen, pp. 169-178. New York, Wiley-Liss, Inc.

Willey, Gordon R., William R. Bullard, Jr., John B. Glass, and James C. Gifford (1965) Prehistoric Maya Settlements in the Belize Valley. Papers of the Peabody Museum of Archaeology and Ethnology, vol. 54. Cambridge, Harvard University.

White, Christine D. (1997) Ancient Diet at Lamanai and Pacbitun: Implications for the Ecological Model of Collapse. In Bones of the Maya: Studies of Ancient Skeletons, ed. Stephen L. Whittington and David M. Reed, pp. 171-180. Washington DC, Smithsonian Institution Press.

White, Christine D. (1998) Diet and Health in the Ancient Maya at Lamanai, Belize. In Diet and Subsistence: Current Archaeological Perspectives, ed. B. V. Kennedy And G. M. LeMoine, pp. 288-296. Calgary, University of Calgary Archaeological Association.

White, Christine D., and Henry P. Schwarcz (1989) Ancient Maya Diet: as Inferred from Isotopic and Elemental Analysis of Human Bone. Journal of Archaeological Science 16:451-474.

White, Christine D., Paul F. Healy, and Henry P. Schwarcz (1993) Intensive Agriculture, Social Status, and Maya Diet at Pacbitun, Belize. Journal of Anthropological Research 49:347-375.

White, Christine D., David M. Pendergast, Fred J. Longstaffe, and Kimberley R. Law (2001) Social Complexity and Food Systems at Altun Ha, Belize: The Isotopic Evidence. Latin American Antiquity 12(4):371-393.

White, Tim D. (2000) Human Osteology, Second Edition. San Diego, CA: Academic Press.

Whittington, Stephen L. (1999) Caries and Antemortem Tooth Loss at Copan: Implications for Commoner Diet. In Reconstructing Ancient Maya Diet, ed. Christine D. White, pp. 151-167. Salt Lake City, University of Utah Press.

Whittington, Stephen L. and David M. Reed (1997) Commoner Diet at Copan: Insights from Stable Isotopes and Porotic Hyperostosis. In Bones of the Maya: Studies of Ancient Skeletons, ed. Stephen L. Whittington and David M. Reed, pp. 157-170. Washington DC, Smithsonian Institution Press.

APPENDIX: DENTAL INVENTORY

Tooth	Adult/Juvenile	Caries	Calculus	Attrition	Abscess	Other
molar	adult-Burial 1	no	no	low	no	
molar	adult-Burial 1	no	yes	low	no	
premolar	adult-Burial 1	no	yes	low	no	
molar	adult-Burial 1	no	yes	high	no	
molar	adult-Burial 1	no	yes	moderate	no	
molar	adult-Burial 1	no	yes	moderate	no	
molar	adult-Burial 1	no	yes	moderate	no	
molar	adult-Burial 1	no	yes	moderate	no	
canine	adult-Burial 1	no	yes	low	no	
premolar	adult-Burial 1	no	yes	low	no	
incisor	adult-Burial 1	no	yes	moderate	no	
molar	juvenile 1-Burial 1	no	no	low	no	
molar	juvenile 1-Burial 1	no	no	moderate	no	
molar	juvenile 1-Burial 1	no	no	moderate	no	
canine	juvenile 1-Burial 1	x	x	x	x	unerupted
molar	juvenile 1-Burial 1	no	no	low	no	
incisor	juvenile 1-Burial 1	no	no	low	no	hypoplasias
incisor	juvenile 1-Burial 1	no	no	low	no	hypoplasias
incisor	juvenile 1-Burial 1	no	no	low	no	hypoplasias
incisor	juvenile 1-Burial 1	no	no	low	no	hypoplasias
canine	juvenile 1-Burial 1	no	no	low	no	hypoplasias
incisor	juvenile 1-Burial 1	no	no	low	no	hypoplasia
incisor	juvenile 1-Burial 1	no	no	low	no	hypoplasia
molar	juvenile-Burial 1	no	no	low	no	
molar	juvenile-Burial 1	yes	no	low	no	
molar	juvenile-Burial 1	x	x	x	x	unerupted
molar	juvenile-Burial 1	x	x	x	x	unerupted
premolar	juvenile-Burial 1	x	x	x	x	unerupted
premolar	juvenile-Burial 1	x	x	x	x	unerupted
premolar	juvenile-Burial 1	x	x	x	x	unerupted
premolar	juvenile-Burial 1	x	x	x	x	unerupted
canine	Juvenile 2-Burial 1	yes	no	moderate	no	
canine	Juvenile 2-Burial 1	no	no	moderate	no	
incisor	Juvenile 2-Burial 1	no	no	moderate	no	
incisor	Juvenile 2-Burial 1	no	no	high	no	
incisor	Juvenile 2-Burial 1	no	no	high	no	
molar	adult-Unit 2e	no	no	low	no	
molar	adult-Unit 2e	no	no	low	no	
molar	adult-Unit 6a	yes	no	moderate	no	
premolar	adult-Unit 2a	no	yes	moderate	no	
molar	adult-Unit 2a	no	yes	high	no	
molar	adult-Unit 2a	no	yes	high	no	
premolar	adult-Unit 2a	no	no	moderate	no	

premolar	adult-Unit 2a	no	no	moderate	no	
incisor	adult-Unit 2a	no	no	moderate	no	
incisor	adult-Unit 2a	no	no	low	no	
canine	adult-Unit 2a	no	no	low	no	
molar	adult-Unit 2a	yes	no	moderate	no	
incisor	adult-Unit 2a	no	no	high	no	
premolar	adult-Unit 2a	no	yes	low	no	
incisor	adult-Unit 2a	no	no	moderate	no	
incisor	adult-Unit 2a	no	no	moderate	no	
incisor	adult-Unit 2a	no	no	high	no	
canine	adult-Unit 2a	no	no	low	no	
molar	adult-Unit 2a	no	no	low	no	
molar	adult-Unit 2a	yes	no	moderate	no	
molar	juvenile-Burial 3	no	yes	low	no	
canine	adult 1-Burial 4	no	no	high	no	
premolar	adult 1-Burial 4	no	no	high	no	
premolar	adult 1-Burial 4	no	yes	high	no	
molar	adult 1-Burial 4	no	yes	high	no	
molar	adult 1-Burial 4	no	yes	moderate	yes	
canine	adult 1-Burial 4	x	x	x	x	impacted
premolar	adult 1-Burial 4	no	no	moderate	no	
molar	adult 1-Burial 4	yes	yes	moderate	no	
molar	adult 1-Burial 4	yes	yes	moderate	no	
molar	adult 1-Burial 4	yes	yes	moderate	no	
canine	adult 1-Burial 4	no	no	high	no	
premolar	adult 1-Burial 4	no	no	high	no	
incisor	adult 1-Burial 4	no	no	high	no	
canine	adult 1-Burial 4	no	yes	high	no	
incisor	adult 1-Burial 4	no	yes	moderate	no	
incisor	adult 1-Burial 4	no	yes	high	no	
molar	adult 1-Burial 4	no	yes	low	no	
incisor	adult 1-Burial 4	no	yes	high	no	
molar	adult 2-Burial 4	yes	yes	high	no	
molar	adult 2-Burial 4	yes	yes	moderate	no	
premolar	adult 2-Burial 4	no	yes	low	no	
premolar	adult 2-Burial 4	no	yes	low	no	
molar	adult 2-Burial 4	no	yes	moderate	no	
molar	adult 2-Burial 4	no	no	high	no	
molar	adult 2-Burial 4	yes	yes	low	no	
premolar	adult 2-Burial 4	no	yes	moderate	no	
molar	adult 2-Burial 4	yes	no	moderate	no	
molar	adult 2-Burial 4	no	yes	moderate	no	
premolar	adult 2-Burial 4	no	yes	low	no	
premolar	adult 2-Burial 4	no	yes	moderate	no	
canine	adult 2-Burial 4	no	yes	moderate	no	
canine	adult 2-Burial 4	no	yes	moderate	no	
premolar	adult 2-Burial 4	no	yes	low	no	
premolar	adult 2-Burial 4	no	yes	low	no	
incisor	adult 2-Burial 4	no	yes	moderate	no	
premolar	adult 2-Burial 4	no	yes	low	no	

molar	adult 2-Burial 4	no	yes	low	no	
molar	adult 2-Burial 4	no	no	low	no	
molar	adult 2-Burial 4	no	yes	low	yes	
canine	adult 2-Burial 4	no	yes	high	no	filing
incisor	adult 2-Burial 4	no	yes	high	no	filing
premolar	juvenile-Burial 4	x	x	x	x	unerupted
molar	adult-Feature 9	no	yes	moderate	no	
molar	adult-Feature 9	no	yes	moderate	no	
molar	adult-Feature 9	no	yes	moderate	no	
molar	adult-Feature 9	no	yes	low	no	
premolar	adult-Feature 9	no	yes	low	no	
premolar	adult-Feature 9	no	yes	low	no	
molar	adult-Feature 9	no	yes	moderate	no	
molar	adult-Feature 9	yes	yes	low	no	
premolar	adult-Feature 9	no	yes	low	no	
premolar	adult-Feature 9	no	no	moderate	no	
premolar	adult-Feature 9	no	yes	moderate	no	
molar	adult-Feature 9	no	yes	low	no	
molar	adult-Feature 9	yes	yes	high	no	
molar	adult-Feature 9	no	yes	moderate	no	
molar	adult-Feature 9	yes	yes	low	no	
incisor	Juvenile 1-Feature 9	no	no	low	no	
molar	Juvenile 2-Feature 9	x	x	x	x	unerupted
molar	Juvenile 2-Feature 9	no	yes	low	no	
molar	Juvenile 2-Feature 9	yes	yes	high	no	
premolar	Juvenile 2-Feature 9	no	no	low	no	
premolar	Juvenile 2-Feature 9	no	no	low	no	
molar	Juvenile 2-Feature 9	no	yes	low	no	
incisor	Juvenile 2-Feature 9	no	yes	low	no	
premolar	Juvenile 2-Feature 9	no	no	low	no	
molar	Juvenile 2-Feature 9	yes	yes	high	no	
molar	adult-Feature 11	no	yes	moderate	no	
premolar	adult-Feature 11	no	no	moderate	no	
molar	adult-Feature 11	no	yes	moderate	no	
molar	adult-Feature 11	no	yes	high	no	
canine	adult-Feature 11	no	yes	high	no	
premolar	adult-Feature 11	no	yes	moderate	no	
molar	adult-Feature 11	yes	yes	moderate	no	
canine	adult-Feature 11	no	yes	moderate	no	
premolar	adult-Feature 11	no	yes	low	no	
premolar	adult-Feature 11	no	yes	low	yes	
molar	adult-Feature 11	no	yes	moderate	no	
molar	adult-Feature 11	no	yes	moderate	no	
premolar	adult-Feature 11	no	yes	moderate	no	
canine	adult-Feature 11	no	yes	low	no	
molar	adult-Feature 11	yes	yes	low	no	
incisor	adult-Feature 11	no	yes	moderate	no	
incisor	adult-Feature 11	no	yes	high	no	

VITA

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